

SCIENCE

[Entered at the Post-Office of New York, N. Y., as Second-Class Matter.]

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

SEVENTH YEAR.
VOL. XIII. NO. 322.

NEW YORK, APRIL 5, 1889.

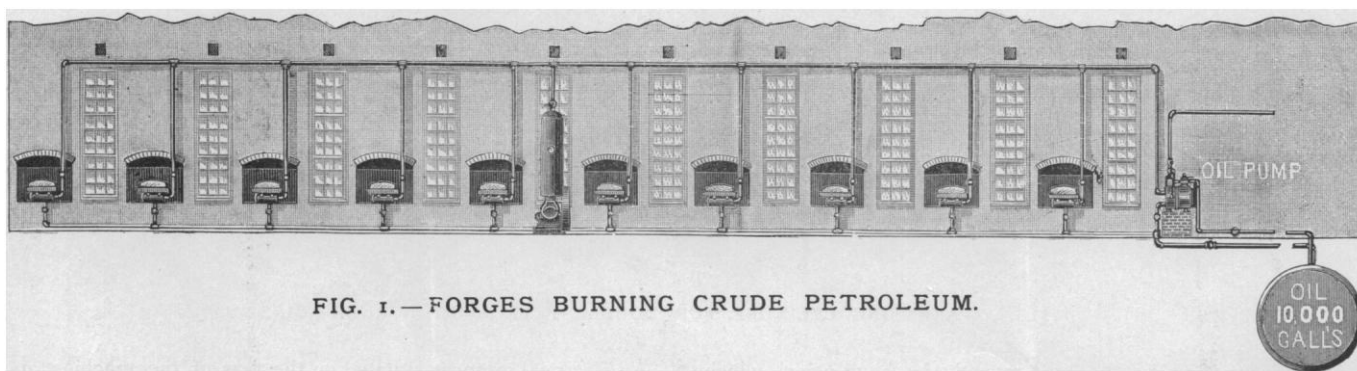
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CRUDE PETROLEUM AS A FUEL.

THE substitution of crude petroleum for coal as fuel in many branches of metal-working, the heating of steam-boilers, etc., has received much attention in recent years. Many devices for feeding the oil to the furnace, controlling the size of the flame, and insuring safety from accident, have been tried, only to be condemned in

sufficient length of time to test it thoroughly in welding, tempering, annealing, enamelling, brazing, japanning, and all kinds of forging and melting of metals; and that the results are satisfactory is shown by the hearty indorsement and commendation given it by those who have it in use.

In this system compressed air is used to atomize the oil, the air-pressure being so regulated as to insure the complete combustion



most cases. These devices depended upon either a steam jet to atomize the oil at the point of ignition, or a system of retorts to heat the oil and convert it into gas before being burned. These systems compel the use of more or less apparatus in the fire-box or furnace; in some cases the retort being placed therein, and in others the fire-box being partly filled with fire-brick or other re-

of the oil, and to preserve a uniform degree of heat of any intensity desired. There are no obstructions placed in the fire-box; so that it is at all times ready to receive coal or other fuel, should the oil-supply fail or a change of fuel be desired. Other good points about this system are its cleanliness and freedom from odor, which are vouched for by those who use it.

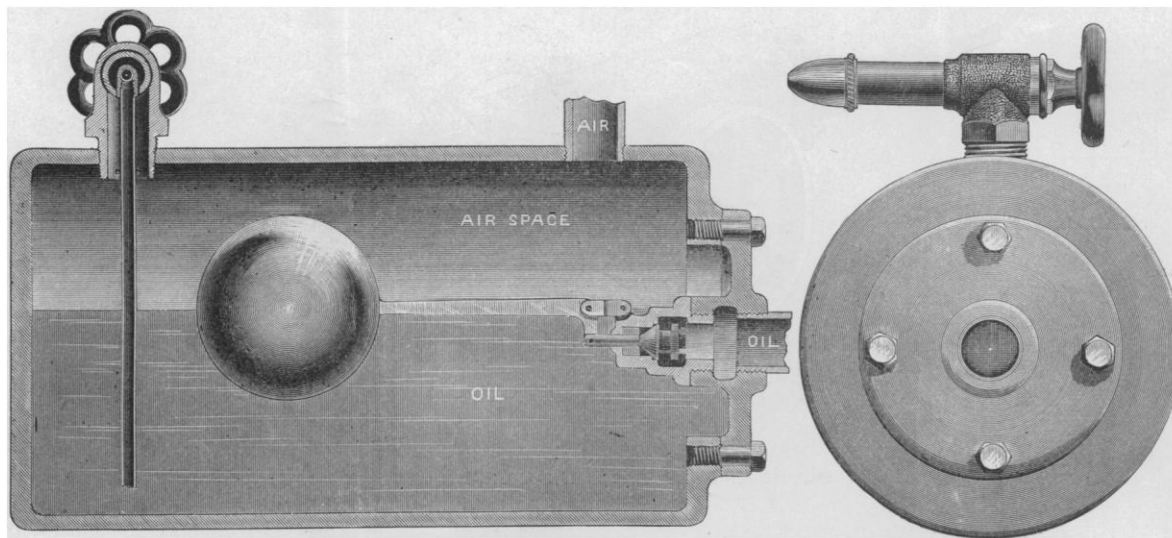


FIG. 2.—AERATING CYLINDER FOR PETROLEUM BURNER.

fractory material, to be heated, and then used as a means to ignite the fuel, distribute the flame, and equalize the heat.

A new method of utilizing crude petroleum for the purposes mentioned is being introduced to public notice by the Aerated Fuel Company of Springfield, Mass. This method has been in use a

The application of this system to forge-fires is shown in Fig. 1, which is a picture of one side of a plant for the forging of nuts and bolts in the works of the Upson Nut Company at Cleveland, O. It is claimed that in works of this kind, the cost of oil for fuel is much less than that of coal; while the dies with which the forging is

done wear longer, as there is less scale on the work. Moreover, the heat is uniform, and can be maintained from morning till night without cessation, enabling the workmen to do more and better work; and there is no smoke, dust, or ashes.

Fig. 2 shows the interior of a burner cylinder with oil inlet at the end. The supply of oil is maintained at a constant level by means of the float, which controls the oil-valve. An end view of the cylinder

THE ELECTRIC COAL-DIGGER.

THIS is the name applied to a new mining-machine, designed and constructed by Elmer A. Sperry of Chicago, and shown in operation at the electrical exhibit of the National Electric Light Association, during its convention in Chicago recently. For five years Mr. A. L. Sweet has experimented on this project, until, with the assistance of Mr. Sperry, success has crowned their efforts.

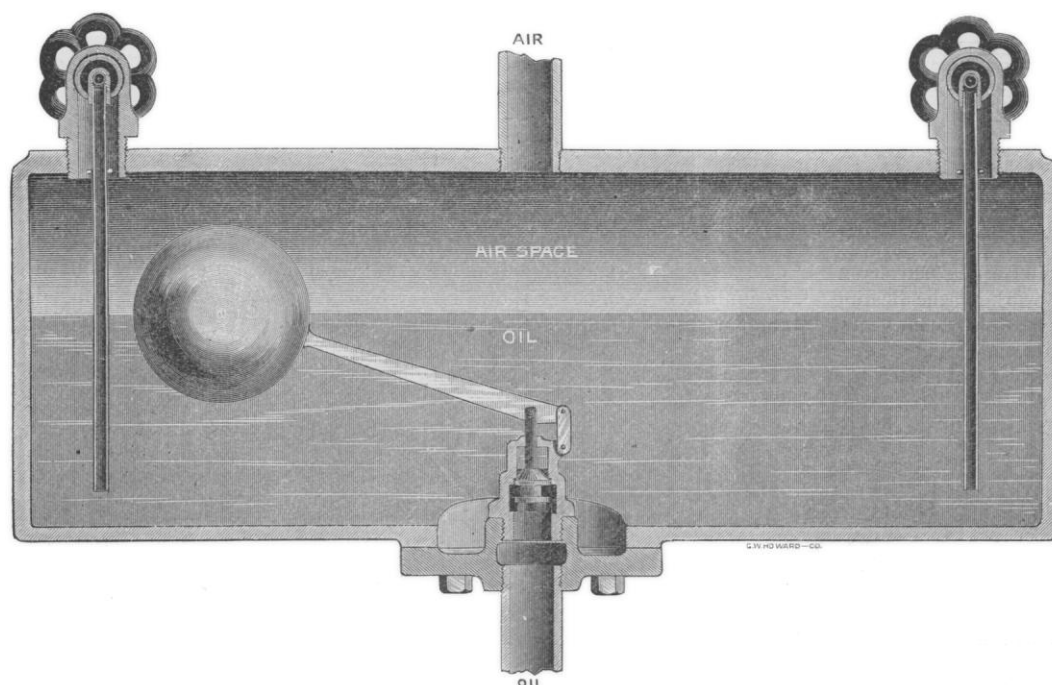
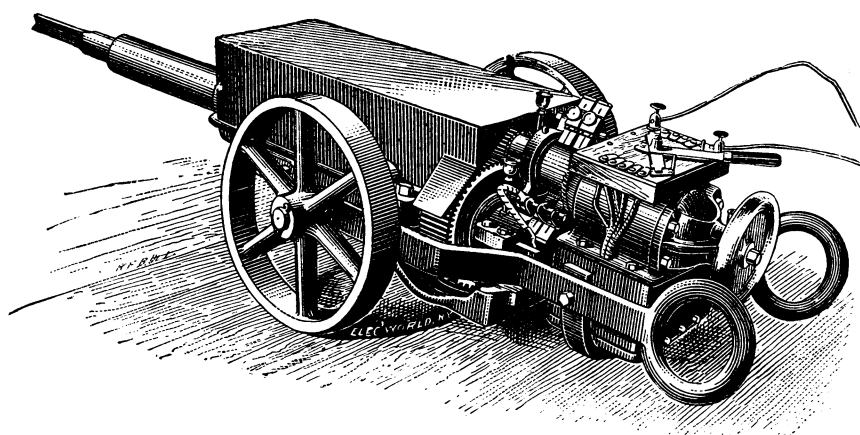


FIG. 3.—AERATING CYLINDER FOR DOUBLE PETROLEUM BURNER.

is also given, showing the burner, and the hand-wheel which regulates or cuts off the supply of air and oil. The operation of the mechanism is as follows: Oil is forced into the cylinder at any desired pressure until checked by the float and valve. At the same time a constant air-pressure is maintained in the cylinder by means of an air-compressor, the air being admitted through the pipe at

An electrical motor is situated on the rear of the machine, and substantial gear-work transmits the power to the mechanism which operates the projectile carrying the pick.

The projectile, including the "bit," "pick," or other colter, weighs from sixty pounds up, depending upon the kind of work. The stroke is from six to eight inches, delivered with a force of



THE SPERRY ELECTRIC COAL-DIGGER.

the top of the cylinder. The hand-wheel being turned, the oil is forced up through the small pipe by the air, while a certain amount of air, proportioned to the oil, passes through the large pipe surrounding the oil-pipe. At the nozzle of the burner, where ignition takes place, the oil and air are commingled, the oil being thoroughly atomized and aerated,—circumstances most favorable to complete combustion. A two-burner cylinder is shown in Fig. 3, in which the oil inlet is at the bottom of the cylinder.

many hundred pounds, and varying from one hundred and fifty to three hundred blows per minute, according to conditions, yet always under control of the operator.

The unique feature of the machine consists in the fact, that, no matter where or at what point in the working stroke the projectile is arrested by the work or face, it is instantly picked up at that point, and returned backward to deliver another blow. For instance: if the normal stroke is six inches, and the pick strikes the

coal after travelling only four inches out of the six, the pick is not left there to push the machine and miner backward away from the work in such manner that the successive blows cannot do effective work; but the moment it has delivered its blow, and without delay, it is withdrawn for the next stroke.

The flexible electrical conductors lead from the dynamo in the engine-room down the shaft and to the machine. It is claimed that the whole design is such that danger from the current is done away with, and that the machine, wires, generator, and every part, are free from danger either to life or property.

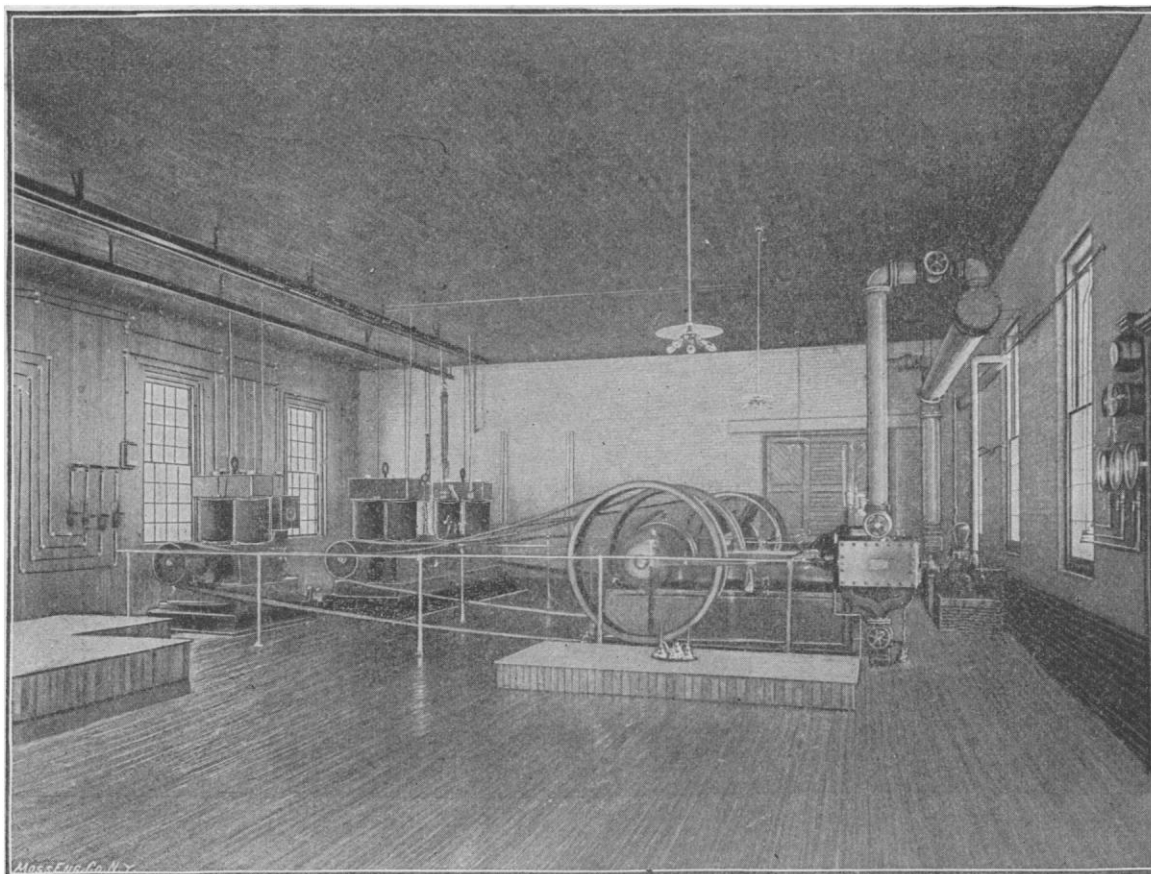
A UNIQUE ELECTRIC POWER STATION.

THE great advantages one method of conversion of energy possesses over another when favored by circumstances is illustrated

eventually prove to be of great economic value. The culm at Scranton is now a marketable product of the mines.

An interior view of the electric power station spoken of is given in the illustration on this page. The electric current is furnished by three Edison dynamos, of 80,000 watts capacity each, wound for an electric pressure of 500 volts at a maximum. The station is most complete in all its appointments, and is furnished with electric lights, current being taken from the dynamos used to supply the motive power for the road.

The twenty cars with which the road is equipped are of the Sprague system, and ran uninterruptedly during the severe snow-storms which have visited Scranton since the road was opened. The Sprague Company and the people of Scranton, as well as the officers of the road, have reason for the satisfaction they express over the working of the road. The extraordinary economy



THE ELECTRIC POWER STATION, SCRANTON, PENN.

in a striking manner at the power station of the People's Electric Railway of Scranton, Penn. At a short distance from this station is an almost inexhaustible supply of "culm,"—the screenings of anthracite coal, which until recently was considered practically valueless. This culm, which costs little more than the expense of carting it to the station, is the fuel used in generating steam for the engine which drives the dynamos, the boiler-furnaces being specially adapted to the economical consumption of such fuel. As a consequence of this cheapness of fuel, it is claimed by the officers of the road, it costs less to supply the electric motive power necessary to operate the railway than it would to furnish one horse with food and attendance. When it is known that there are twenty cars in operation on this line, and that the grades are not few in number, some of them being steep, the enormous advantages given to the electric system by such exceptional favoring circumstances are apparent at a glance. The results of two months' experience on the Scranton road makes prominent not only the fact that the electric railway is a good thing in its way, but also the further fact that many things now looked upon as useless will

in working expenses, if nothing else, makes this a notable electric railway.

A COTTON FABRIC.

A COTTON fabric which has been patented in England is thus described by the *Canadian Journal of Fabrics*: "It has the appearance and soft feel of chamois leather, and, it is guaranteed, will not lose its special qualities when washed. In making the cloth, cotton yarns form the warps, these being dyed a fast color, a chrome yellow tint being preferable. They are sized and dressed in the usual manner. The weft is spun soft, and is used in the undyed state. The fabric is woven from these yarns, and is then passed several times through cylinder teasing or raising machines, whereby the surface is broken and a good ground nap is produced on one side or both sides thereof. The fabric is then 'soap' finished, to impart to it the desired appearance and soft, cold feel of chamois-leather. It is applicable for either wet or dry cleaning purposes and also as a polishing cloth, and especially suitable for underclothing and for linings of the same, and for general use as a

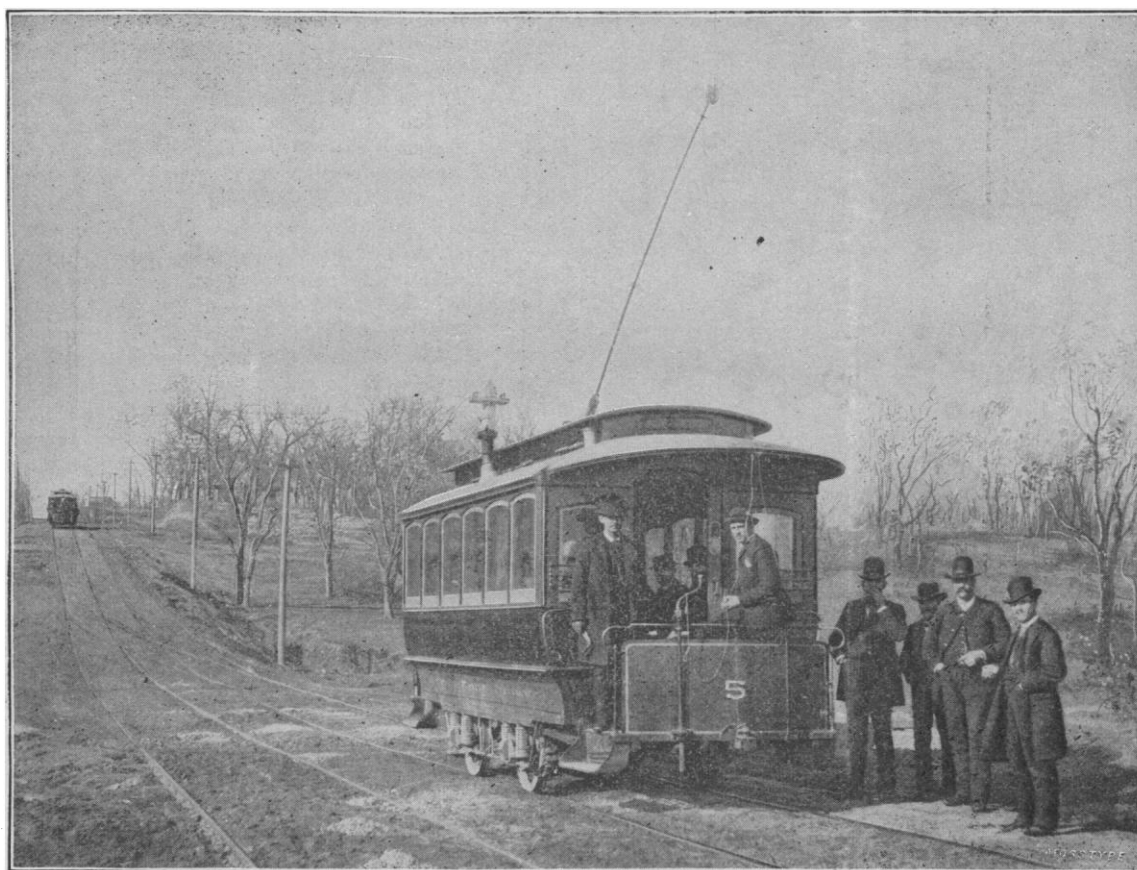
substitute for the chamois-leather now used for these and for analogous purposes. Being, moreover, of a woven texture, and absorbent, it is more healthy for use in garments than chamois-leather, and does not require to be perforated. Unlike leather, also, which gets stiff after washing, this improved material so produced is capable of being repeatedly washed without stiffening, and is found to retain its softness perpetually."

THE ELECTRIC RAILWAY IN ST. JOSEPH, MO.

ONE of the successful electric street-railways in the country is that in operation upon the Wyatt Park Company's line at St. Joseph, Mo., a view of which we give in this issue. This line at St. Joseph was the first one in the country to practically demonstrate the successful operation of an electric railway in a snow-storm. In the early

A NEW FORM OF SELF INDUCTION AND REGULATING COIL.

IN the operation of electric lighting and other apparatus in which an alternating current is employed, it is frequently desirable to vary the current or electro-motive force through considerable range. With direct or continuous currents, a variable rheostat is usually employed for such purpose, and, where saving of energy is not an object, might be used also with alternating currents. But with such currents it is possible, by employing self-induction or inductive resistance in place of pure resistance, to secure such variations without much loss of energy, because the action of self-induction is really only a storing-up and giving-back of energy consequent on a displacement of phase of induced alternating impulses from the phase of impressed or supplied impulses. This is what is



SPRAGUE ELECTRIC RAILWAY AT ST. JOSEPH, MO.

part of this winter a blizzard from the Western prairies struck St. Joseph with all its force, and covered the streets in that city to the depth of from six inches to one foot, in many places drifting badly. The telephone, telegraph, and electric-light wires were borne down by the snow in all parts of the city. In spite of this general blockade, the electric railway ran uninterruptedly, and the cars ploughed their way through the heavy drifts on the line without trouble or stoppage, and without any aid from snow-ploughs.

The grades on the Wyatt Park Railway are in some points on the road as high as nine per cent; and the cars reach a speed of fifteen to eighteen miles an hour in the outside and suburban districts, reducing to a lower rate of speed when operating within the city.

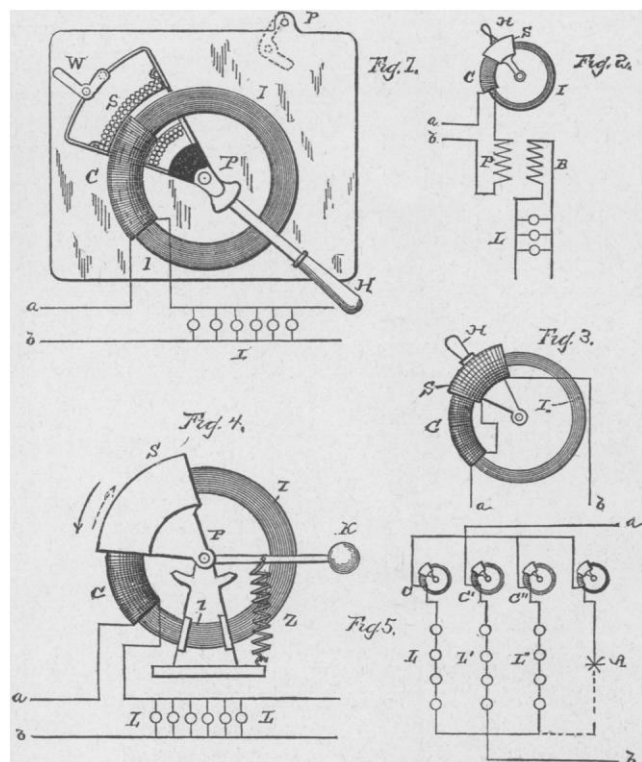
St. Joseph, Mo., already has two street-railways operating by electricity on the Sprague system, and a great many manufacturing industries are kept in operation by the same power by means of stationary electric motors operated from the regular railway circuit. It is said that the two other street-railways in St. Joseph will soon be in operation upon the electric system, so that the horse shall be supplanted entirely for car service in that city.

meant by "lagging of phase," and it is an effect of self-induction or inductive resistance. Any wire capable of producing magnetism is a self-inductive resistance to such currents. A coil wound on an iron-wire core or bundle is a good example; and, if the wire bundle be a ring core or closed magnetic circuit, its effects per unit of length of wire will be enormously intensified.

Hitherto the usual plan of constructing a variable inductive resistance has been to provide a hollow coil with a movable iron-wire core in its axis, so that the centres of coil and core could be made coincident for maximum effect. This arrangement for a given effectiveness is cumbrous and unnecessarily large, inasmuch as it employs only an open magnetic circuit, and not a closed one; and, even though the core be entirely removed from the coil, the self-induction is not neutralized, because of the numerous turns of wire in the coil itself. Besides, the true resistance of the wire as such is considerable.

With a view of obviating these defects, and securing the other advantages of compactness and ease of manipulation, the apparatus to be described was devised.

It has already been applied to a number of cases of practical work, where it takes the place, for alternating-current work, of variable resistances, while it saves the energy of the circuit. It is also made self-adjusting, and can maintain a constant average of alternating current over a variable resistance, such as a series of incandescent or arc lamps connected across the terminals of a system or machine of alternating character.



It is based on the principle of the demagnetizing effect of a closed coil or circuit parallel to the coil or circuit in which the inductive resistance is to be varied; the relation of position of the two coils on a magnetizable core forming a closed magnetic circuit, or nearly so, being made variable.

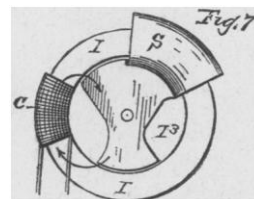
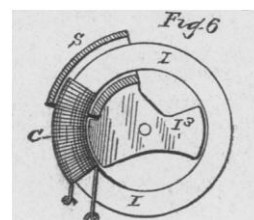
In Fig. 1, II is an iron core, preferably of ring or endless form, made of wire or laminae, suitably piled and insulated to avoid Foucault currents; C is a coil of insulated wire wound on the core, as shown; S is a closed band or coil around the ring, and arranged to be moved over the coil C by a handle, H , and pivoted at P when preferred, though it could simply be slipped along in some cases. Let, now, an alternating current of fairly constant potential be feeding the lamps L, L , from a to b , with the coil C in circuit. If the closed coil or band, S , be brought down over the coil C , very little re-action or self-induction will exist in the coil C ; and, if its resistance be low, the lights L, L , will be given their full brilliancy. If the coils S and C be now separated more and more by moving one away from the other around the ring, the self-induction of coil C progressively rises, and becomes greatest when coil S is farthest removed from it. The lights are now dimmed as far as possible, any gradation being obtained by setting the coil S in a position with respect to coil C corresponding to the desired effect. The action is smooth and very effective. If a switch, W , be placed in circuit with the coil S so as to be opened when it strikes a pin, p , suitably placed, and after the coils C and S have been widely separated, the effect of coil C is further enhanced in dimming the lights or in exerting a self-induction which checks the current in any device with which the apparatus may be put in circuit.

In Fig. 2 the devices are shown placed in series, with a primary coil, P , of a transformer, whose secondary, B , feeds the lights L , or other devices, with current. A very smooth and powerful resisting effect may thus be obtained with moderate sizes of apparatus.

If the directions of windings are made opposite, the two coils C and S , as in Fig. 3, may be connected in series or multiple arc, and the current led from a to b through them. They should in such cases be wound to have equal ampère turns capacity in magnetizing the core I . When the coils are superposed, they will neutralize one another's self-induction; but, as they are separated, the self-inductive kick or re-action will gradually increase. The variation of induction or re-action is obtained without contacts and switches, and in a smooth and gradual manner.

In the preceding figures the devices shown have been arranged to be operated manually. The same devices, however, if the parts are relatively free to move, give out, from alternating currents, a mechanical power or pressure which may repel the coils apart. To obtain a movement of coil S , or pressure tending to move it, coil C has only to be put into an alternating-current circuit. Further, this repulsive power may be utilized to make the self-induction self-adjusting, whereby there may be obtained a constant current on the circuit of a set of lamps, or the like, even though variations of voltage of current fed to them may occur. Thus, as in Fig. 4, the source, a, b , of current may be one which varies in potential, the coil C being put in series with a group of lamps, L, L . In this case the copper band or closed circuit S is pivoted freely at P , and counterpoised to a certain extent by a lever and weight, K , or other device, whose effect may be varied if need be. Sometimes a spring, Z , may be used in addition (or even alone, if of proper retractile effect), and suitable stops may be provided to limit the range of movement. Suppose that the coil S is set, and so balanced that, with a given current in coil C , it is repelled so as to about half cover the coil C (or less, if the counter-forces K, Z , are properly adjusted), and that an increase of current, due to increased potential, takes place in the circuit A . Coil C will more strongly repel circuit or band S , and it will move partly up and away, with the result of increased self-induction in coil C ; which self-induction, if the parts are suitably adjusted, will approximately restore the current strength to what it was before the change. A fall of potential corrects itself by working in the reverse direction.

The apparatus in this self-regulating or automatic form is to be used in such circuits as are represented in Fig. 5, where wires a, b , of constant or even somewhat variable potential difference, feed in multiple several separate series of lights, L, L', L'' , such as incan-



descent or arc lights with alternating currents. Each series, circuit, or branch requires a constant current; and to insure this, even though a light be cut out in any series, the automatic self-inductors of Fig. 4 are placed in each branch or series at C, C', C'' , where each acts, as described in connection with Fig. 4, to preserve the current strength. Of course, the group L (Fig. 4), or series L, L', L'' , may be replaced by a single light or translating device, such as an arc-lamp, without affecting the result. This has been indicated at A (Fig. 5), always assuming the potentials to be not so excessive or so feeble as to exhaust the capacity for regulation to be found in the device.

In Figs. 6 and 7 the part I'' is of iron, as shown, and carries

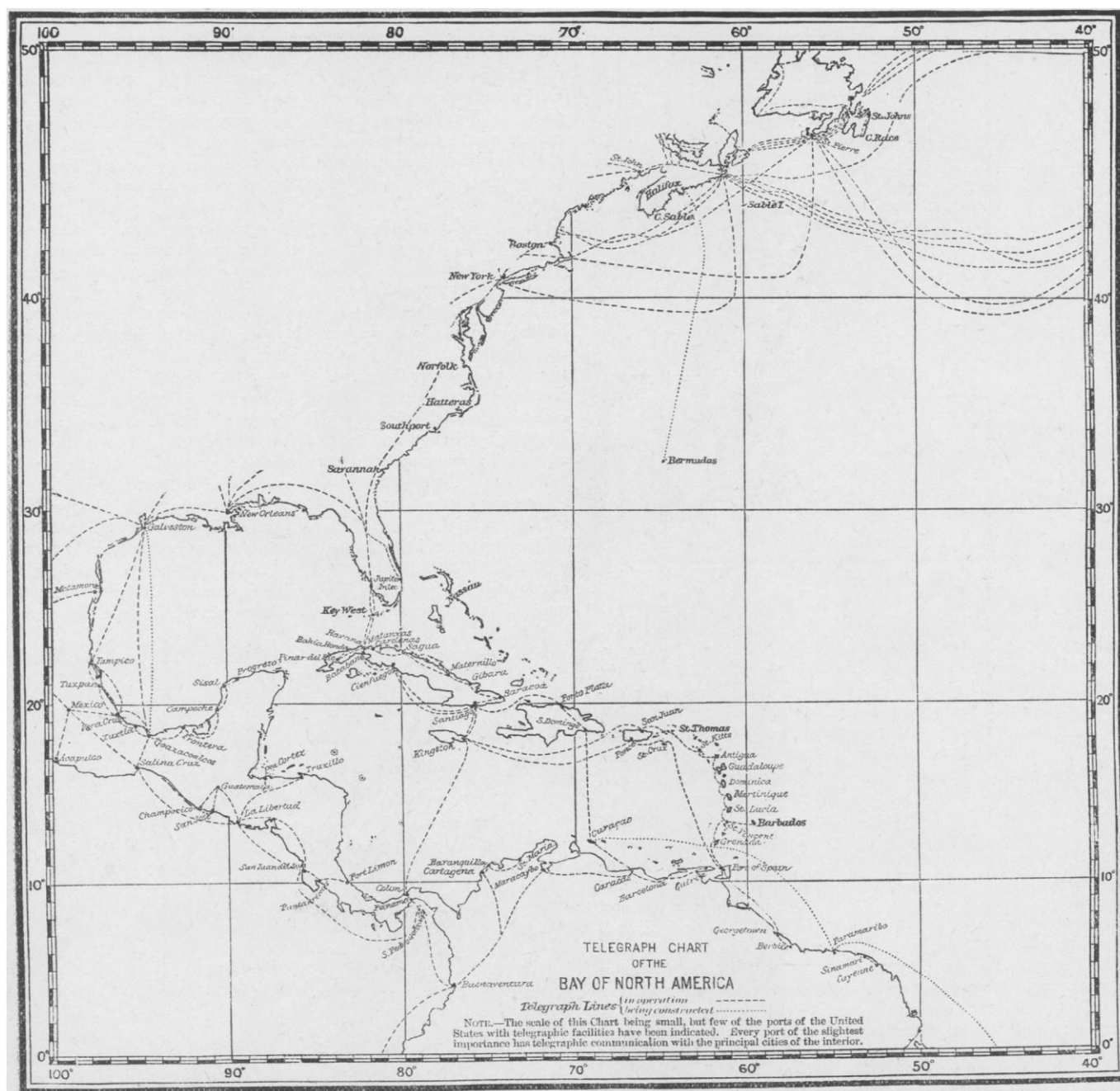
coil or band *S*. When the coils or circuits *S* and *C* are separated, as in Fig. 7, a closed iron path for the core *I*, as indicated by the arrows, is afforded the iron *I'*", operating after the manner of an armature, and comes into play to increase the effective self-induction of the coil *C*.

ELIHU THOMSON.

WEST INDIAN HURRICANES.

THE Bay of North America is that portion of the North Atlantic west of the 50th meridian, between Newfoundland and Venezuela, including the Caribbean Sea and Gulf of Mexico. In accordance

the higher latitudes. West Indian hurricanes follow this path with marked regularity; so much so, that a hurricane reported off Antigua or St. Thomas is almost sure to either sweep across the Greater Antilles into the Gulf of Mexico and strike our Gulf coast with furious intensity, or else (according to the time of the year) cross the Bahamas and follow the Gulf Stream toward Hatteras and the Grand Banks. With the telegraphic facilities that already exist, it is therefore possible to give from twenty-four hours to ten days' warning of the approach of one of these terrific tropical cyclones, — warning that might often result in the saving of more property ashore and at sea in a single storm (not to speak of the



with the policy followed hitherto by the United States Hydrographic Office, of calling attention to matters of special importance to navigators, on "The Monthly Atlantic Pilot Chart," a telegraphic chart, which we here reproduce, has been prepared to illustrate the admirable facilities that are available for the establishment of a more complete system of telegraphic weather forecasts, for the benefit of the commerce of various nations frequenting this great bay, as well as of the inhabitants of its shores and islands. The general movement of storms over this area is westward in the tropics, then northward into the temperate zone, and eastward in

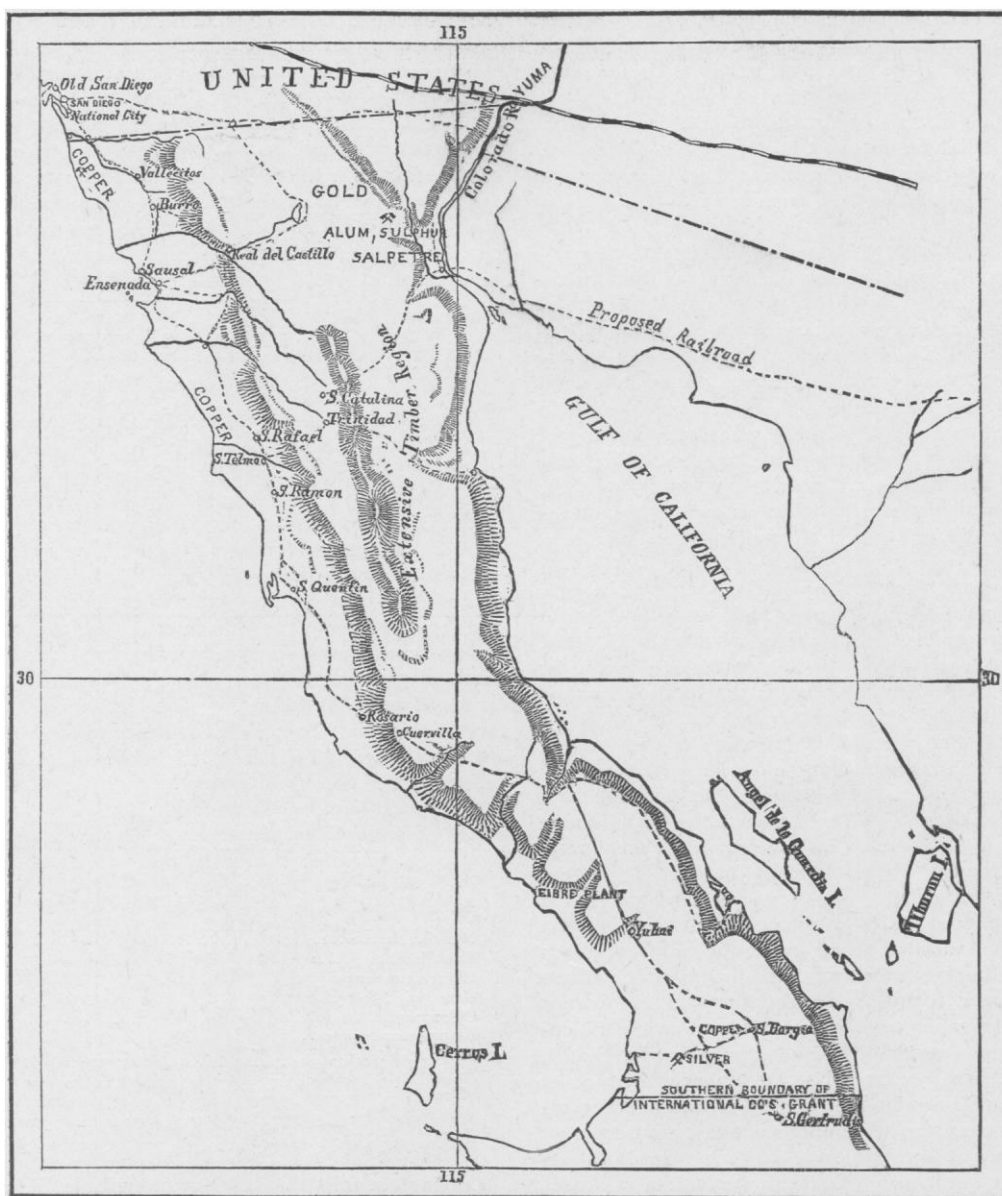
lives endangered) than would suffice to pay for the cost of a well-equipped weather service for several years. Moreover, it is well known that the movement of an area of low barometer is controlled to a very large extent by areas of high barometer adjacent to it, especially in advance (even though a thousand miles away), and many noticeable instances might be referred to: the hurricane in the Gulf in August, 1886, for example; the March blizzard of last year; and the severe cyclone off the coast last November. The wider the field of observation, therefore, the better the forecast; and the completion of the cable to Bermuda will be invaluable in

connection with forecasts of weather along our entire Atlantic sea-board.

An officer detailed from the Hydrographic Office to visit Havana last September, in order to consult with Padre Viñes, the leading authority on West Indian hurricanes, secured also the cordial co-operation of Capt. Carbonell, the director of the newly established marine observatory there; and the French and Spanish cable companies have granted the franking privilege for telegrams over their lines whenever the weather is disturbed. The chief signal officer, United States Army, has offered every assistance in his power in order to secure the best results during the coming hurricane sea-

COLONIZATION OF LOWER CALIFORNIA.

COMPANIES which attempt to promote immigration into Mexico have to contend against serious political prejudices, which are not readily counterbalanced by even great prospective productivity of the land they offer for sale. Most attempts on large and small scales have failed on account of this fact. One of the most important and promising enterprises of this kind is that of the International Company of Hartford, which, by the Colonization Act of 1883, received a grant of the northern portion of Lower California. It appears that the company finds some difficulty in inducing sufficient



son; and it would seem, that, by means of earnest co-operation, the dangers of storms that traverse the Bay of North America might be greatly reduced, and a large loss of life and property be avoided annually. To navigators, especially, this is a subject of great importance, as timely warning may enable them not only to avoid the dangerous regions of an approaching storm, but actually take advantage of it to prosecute their voyages. The attention of all those interested in the commerce of the Bay of North America, and the security of the inhabitants of its shores and islands, is therefore specially called to the importance of this subject.

THE Long Island College Hospital recently graduated a class of forty-seven men.

numbers of colonists to settle in this region; and, as a chapter of its charter requires the settlement of a certain number of families in a certain period, difficulties arose. The *New York Times* remarks upon this subject in a recent issue.

The International Company, as is well known, has its principal sphere of operations in Lower California; and the chief aim of Mexico in granting such large concessions to the company was to secure the speedy survey and settlement of that territory. A leading stipulation, in fact, in the company's charter, which was granted in 1883, was that within ten years there should be settled in the territory granted at least two thousand families as colonists; and it was the alleged failure to have brought in the requisite number of settlers up to the time of the close of the inspection of the

company's affairs by the government, within the past year, that was made the most serious charge in the inspector's report. It is too soon to say what the outcome of all this will be, though it seems highly probable that the company's charter will be modified, and its administration re-organized.

Mexico was a long time in cutting loose from the old Spanish ideas of national exclusiveness. Various slight changes were made from time to time in the laws of the colonial period, aimed at foreigners; but it was not until 1842 that foreigners were allowed to own real estate in Mexico, and even then they were hedged about with many restrictions, such as the prohibition of holding more than two pieces of property in the same political department. Yet the country has long been desirous of enjoying the benefits of immigration. Efforts to secure them have been made along two lines. Many contracts have been made for the survey and opening of unoccupied lands, payment for the work being partly made in grants of lands, with the hope of inducing colonization to take them up; and the government has directly undertaken to plant and support colonies. Both methods have resulted, in the words of Minister Pacheco in a special report on the subject made last year, "only in bitter disappointment and the loss of large sums to the national treasury."

Particularly costly and disastrous were the attempts at colonization made by President Gonzales during the term of his administration. Italian immigration was the thing he aimed at. Large bodies of immigrants were induced to come from Italy; many Italians went to Mexico from New York, the Mexican consuls getting so much a head for every one shipped, and were located on government lands selected for the purpose. But the plan was wretchedly conceived, and came to nothing except great suffering to the immigrants, and immense expenditures to the treasury. The minister of public works, in the report alluded to, referring to these experiments, says that the outlay upon them amounted to upward of \$1,500,000, and that there is practically nothing to show for it all to-day.

It would be easy to assign reasons for this long series of failures. The unsettled condition of the government, bad systems of taxation, poor methods of farming, and lack of means of transportation, have undoubtedly had much to do with the unsatisfactory results; but perhaps a deeper cause than any other is the lack of demand for small holdings of land. The system of great ranches seems to be the only one possible or profitable in the case of the land at present unoccupied. Small farming can be carried on successfully only in the neighborhood of cities, and there all the available land has long since found owners. A farm of a few acres in a remote location is practically of no value to its owner. This was pretty thoroughly shown in the experiments tried by Juarez. He had the French communal system made obligatory in certain localities, in the hope of raising up a generation of small proprietors; but in a very short time it was found that all the owners of small holdings had sold out, so that the land was again in the hands of one or two ranchmen. That there is really no demand for small properties anywhere along the American frontier, is also shown in the ridiculously low prices set upon government lands in the border States. According to a presidential decree of last December, the price of public lands in those localities for 1889 and 1890 was fixed at an average of about fifty cents the hectare, or say twenty-five cents an acre. With thousands of acres for sale at such prices, and no bidders, the difficulties in the way of Mexican colonization are of themselves apparent.

Notwithstanding the numerous failures at colonizing portions of Mexico, we cannot but consider the prospects of a great part of the area owned by the International Company as favorable. The rapid progress of Southern California cannot fail to have a beneficial influence upon the adjoining region, which is very similar to it in character. Formerly the whole of the peninsula was considered a desert; but it has been shown that in its northern portion there is an abundant supply of water. This is derived from the great chain of mountains indicated on the accompanying sketch-map, the highest parts of which are said to be more than ten thousand feet in height. Mr. C. Nordhoff, in his pamphlet "Peninsula California," quotes the following description of this mountain-range from a report of its explorer, Col. D. K. Allen: "This great mountain region

lies about one hundred miles south-east of Ensenada, seventy-five miles east of San Quintin, and from thirty to thirty-five miles west of the Gulf of California. The range is about one hundred and ten miles in length, and from fifteen to thirty in width. Water is abundant everywhere, and only has to be husbanded in order to furnish a great supply for all the lands on the north end of the peninsula. These streams can be easily and cheaply dammed, and all of the pine can be put into them and floated down to the heads of the valleys. This can be done with the San Rafael, which is a grand stream with five large branches, draining nearly all of the north end of San Pedro; also with the San Domingo, which drains the western side of the mountains; and the logs or timber can be taken out at the upper end of San Rafael valley near Colnett, or at the upper end of San Quintin valley near San Ramon. Either water route is perfectly feasible."

The peninsula is undoubtedly rich in minerals, but its great development in this direction can come only with a denser population. Gold, silver, and copper are at present worked by various companies. With these possibilities of irrigation, with a healthful climate favorable to the carrying-on of valuable cultures, with good pastures in the mountainous region and an ample supply of timber, and with rich mineral deposits, there can be no doubt that the country will be developed as soon as its political state appears sufficiently stable.

HEALTH MATTERS.

The Use of Tobacco.

IN a communication to the *New York Medical Record*, Dr. F. H. Bosworth discusses the effect of the use of tobacco on the health. He says that the Anglo-Saxon races have been smoking and chewing now for nearly four hundred years. They contracted the habit from a race which, as far as history and tradition teach us, were remarkable for their vigor of body and mind as well, and, as far as we know, were an unusually long-lived people. In the time that we have been using the weed there is no evidence to show that the race has in any way deteriorated, but, on the contrary, it is abundantly shown that the average duration of life has increased nearly fifty per cent. There is no evidence to show that in this time the race has been more subject to disease, but rather that they are less so. There is no evidence to show that the race has lost any thing in its intellectual activity, but, on the contrary, it has been a time of most marvellous fecundity in all that is great in literature.

He gives the following analysis of tobacco, that of Passelt and Reinmann, which is accepted as correct by authorities:—

Analysis of the Leaf.

Nicotine.....	0.060
Volatile oil.....	0.010
Bitter extractive matter.....	2.870
Gum and malate of lime.....	1.740
Chlorophyll.....	0.267
Albumen and gluten.....	1.308
Malic acid.....	0.510
Salts of pot. ammonia, etc.....	0.734
Silica.....	0.088
Water.....	88.280
	100.00

Leaving out from this analysis the volatile oil, extractive matter, albumen, gluten, and chlorophyll, and negative and inert matter, and we have left a substance containing 1 part of nicotine, 4 parts of salts of lime, ammonia, etc., with 88 parts of water in 100. The percentage of nicotine in various kinds of tobacco varies; Havana tobacco containing but two per cent of this poisonous element, while Virginia tobacco contains about seven per cent, according to some analyses. The moral of this is that we should always smoke the choicest brands of Havana cigars. In smoking, the ammonia salt may become the source of considerable discomfort in the burning and smarting tongue which results from excessive and continuous practice of the habit: of course, in chewing, this action is not noticeable. We thus are reduced to the action of nicotine for the possible deleterious influence of the plant. This element, as before stated, is present in varying proportions in the tobacco-leaf;

according to some writers, from one to seven per cent. It is a clear and colorless fluid, highly volatile, and of an extremely pungent, disagreeable odor, and strong, burning taste. It is rapidly absorbed into the fluids of the body, and is one of the most deadly poisons known. It is rendered volatile by burning the leaf, and is present in the smoke of the tobacco. It is generally accepted that the volatilized nicotine in the tobacco-smoke is more actively absorbed than is the case when the leaf is chewed; but in either case the nicotine absorption is the essential element in the production of all of the evils which can be charged to the habit. Nicotine acts on the heart, nervous system, stomach, and upper air-passages. The prominent symptoms which may be caused by nicotine, with reference to the heart, are intermission and palpitation; that is, it produces certain functional disturbances of the heart, which, for the time, may be the source of more or less discomfort to the patient; but the important point is, does this condition ever lead to one of organic lesion?

Dr. Bosworth thinks that the action of nicotine on the nervous system may be summed up by the statement that it produces disturbance of brain, giddiness, muscular tremors with exhaustion, sleeplessness, and depression of spirits. He does not advocate the use of tobacco, but asks, "Are we not often liable to fall into a mistake in universally condemning its use without sufficient grounds, and is it not better when our advice, as physicians, is asked, in this respect, to base our answers entirely on the evidences of the effect of the drug upon each individual patient, and, furthermore, to recognize the fact that this effect is shown by well-marked and easily recognized subjective symptoms? I have frequently, when asked this question, 'Does smoking hurt me?' frankly said to my patients, 'You know better than I do; no man uses tobacco to his harm without being fully conscious of it.' As regards its effect on the diseases of the upper air-passages, in a practice of twenty years largely devoted to treatment of these affections, I recall but exceedingly few cases wherein I have found it necessary to interdict the use of tobacco as injuriously affecting in any way these passages, or as interfering with the success of treatment."

The object of this paper is not a plea for the use of tobacco, but simply to suggest whether we had not best abandon the idea that it is a drug whose use is pernicious in every way to body, mind, and morals, and rather to take the view that it is one of God's good gifts to man, — a "virtuous herb, divine, rare, superexcellent tobacco" when properly used, but when taken "as tinkers do ale, 'tis hellish, devilish, and damned tobacco."

Diphtheria.

THE subject of diphtheria is now attracting unusual attention on the part of boards of health and physicians throughout the country. The Kings County Medical Association has spent the entire winter in its discussion, and the medical profession of Boston has recently devoted a great deal of time and thought to its causation and methods of prevention. In the present number we give a *résumé* of the discussions and reports as they have appeared in the meetings of the Suffolk District Medical Society. There is no question more important for sanitarians to consider than the means of preventing the spread of this dread malady. From a recent report we find that in a single week its victims were as follows: in Brooklyn, 21; New York, 47; Philadelphia, 6; St. Louis, 11; Chicago, 26; Boston, 11; Cincinnati, 10; Paris, France, 37; and London, 25. It has become a permanent resident in almost every city of the world. In the treatment of this disease, but little progress has been made. If its ravages are ever to be lessened, it must be done through its prevention.

Dr. J. H. McCollom has presented to the Suffolk District Medical Society some observations on diphtheria in Boston during the year 1888. Of this disease, 1,411 cases occurred during that period, of which 470, or 33.3 per cent were fatal. After a thorough study of the facts, he comes to the conclusion that the theory advanced by some recent observers, that diphtheria prevails more extensively in the vicinity of old water-courses and dry river-beds, certainly is not tenable so far as that district is concerned. Neither does the theory of defective drainage explain the prevalence of the disease: for, in the first instance, there are no old water-courses or dry river-beds in that locality; and, in the second place, the drainage the

past year, when there has been a large number of cases, has been much better than in 1887, when there were very few cases. Contagion is, therefore, the only possible explanation for this condition. From the opinion of the observers cited, from the fact that the disease has invaded districts where the sanitary conditions were remarkably good, from the fact that out of 1,117 examinations in only 596 instances was defective drainage found, from the fact that the source of contagion could only be traced in 276 instances out of 1,383 reported cases, and from the fact that there has been a marked increase in the disease when children were brought together in large numbers, it would seem that the general extension of the disease must be attributed to contagion; not from the recognized, but from the unknown and mild cases.

At a recent meeting of the same society a committee was appointed to confer with the board of health as to the necessity and feasibility of further measures to limit the spread of diphtheria. The committee, at the last meeting, reported that under the existing laws the board has authority to isolate cases of diphtheria which are reported to them, or in any way fall under their observation, but that this power is not in all cases available, for lack of proper financial means. They may, for instance, send cases to the City Hospital or other institutions willing to receive them, and having proper facilities for isolation and treatment; but, once there, the authority of the board ceases, and they cannot prevent the removal of the case at any time by its parents, guardians, or friends, nor can the hospital authorities compel their patients to remain. The board can also compel proper disinfection where cases are made known to them. They can enforce the legal penalties for non-report on the part of physicians, but are here met with the well-known fact that in many cases it is impossible for the most skilful diagnostician to differentiate for the first twenty-four or even forty-eight hours between non-contagious, tonsillar, pharyngeal, and nasal diseases and genuine diphtheria. There is a belief among those not well informed, of the community, that this disease is neither infectious nor contagious, and may therefore be safely and more conveniently treated in their own houses. It is believed by the committee that very much may be done in this direction through the influence of this society by creating more correct views in the public at large as to the contagiousness of the disease, the absolute necessity of isolation, and a more earnest co-operation with the board of health. The public has now become so fully enlightened as to the dangers from small-pox, that the board meet with comparatively little opposition in the most stringent and arbitrary enforcement of isolation, so far as that disease is concerned; and it is believed that the same enlightenment with regard to diphtheria would do very much towards diminishing its spread by inducing a more ready compliance with the necessary measures of isolation and disinfection. The committee recommends that this society, both collectively and individually, should foster, so far as they can, a proper sentiment in the community as to the contagiousness of this disease, and more especially should encourage its earliest possible recognition and report to the board of health in each individual case. By these methods a public sentiment will sooner or later be created, justifying and requiring from the proper authorities a suitable separate hospital for the treatment of infectious and contagious diseases, such, for instance, as is required by law in England, with ample means for its support, and over which there shall be as absolute authority as already exists over the hospital for small-pox. In the absence of these necessary facilities for thorough isolation, it is impossible to exercise an efficient control over the various dangerous diseases that from time to time become epidemics in our cities, or which have gained a permanent foothold in Boston.

The Boston Board of Health has issued a circular for the purpose of more widely extending the knowledge of a few well-attested facts concerning diphtheria, and reminding all persons that greater care should be exercised to prevent the spread of this much-dreaded disease. The circular states that diphtheria is contagious and infectious, and may be easily communicated, either directly or indirectly, from person to person. It may be conveyed directly in the act of kissing, coughing, spitting, sneezing; or indirectly by infected articles used, as towels, napkins, handkerchiefs, etc. The poison clings with great tenacity to rooms, houses, articles of furni-

ture and clothing, and may occasion the disease even after the lapse of months. Diphtheria attacks all classes, at all ages, and at all seasons of the year. By preference it attacks children and those who are debilitated from exposure to filth, dampness, or foul air from whatever source. When a case of diphtheria occurs in any family, the sick person should, if possible, be taken to a hospital; otherwise he should be placed in an upper room apart from the inmates of the house, and should be nursed, as far as possible, by one person only. The sick-chamber should be well warmed, exposed to sunlight, and well aired; its furniture should be such as will permit of cleansing without injury; and all extra articles, such as window and table drapery, woollen carpets, upholstered furniture, and all hangings, should be removed from the room during the sickness. The physician and nurse, as a rule, should be the only persons admitted to the room.

Visitors to the infected house should be warned of the presence of a dangerous disease therein, and children especially should not be admitted. All clothing removed from the patient or the bed should be at once placed in a solution of corrosive sublimate—two drams to the gallon of water, in a wooden vessel—by the nurse before being carried through the house or handled by any other person. They may be soaked in this fluid for a convenient time, and then boiled for one hour. It is better not to use handkerchiefs for cleansing the nostrils and mouth of the patient, but rather soft rags, which should be immediately thereafter burned. All vessels for receiving the discharges of the patients should constantly contain some of the disinfecting liquid. Water-closets and privies in the house should be disinfected daily with a solution of fresh chloride of lime (half a pound to the gallon of water). Every kind and source of filth in and around the house should be thoroughly removed, and disinfectants freely used. Cleanliness tends both to prevent and mitigate the disease. Drains should be put in perfect order and ventilated by a four-inch straight pipe extended above the highest point of the roof of the house in every instance, terminating at a distance from any chimney or other ventilator. Children in the family should not attend school or mingle with other children until the patient has wholly recovered and all infected articles have been disinfected, and these facts certified by a responsible physician.

On the recovery, removal, or death of the patient, the most thorough disinfection should follow. Close up all apertures in the room tightly; hang up, unfolded, all articles of bedding, clothing, etc.; remove all mattress-covers for the free exposure of their contents; place in an iron pan four pounds of brimstone for each thousand cubic feet of space in the room; place the pan on two bricks or an iron rest in a tub containing water; pour a little alcohol on the brimstone, ignite it with a match, and leave the room closed tightly and guarded for not less than ten hours. The fumes of burning brimstone are dangerous to breathe, and will kill animals and plants. After fumigating has been done, the room and every thing in it should be thoroughly aired. The walls and ceilings should be brushed, and the floors and other wood-work washed with water containing two drams of corrosive sublimate to the gallon of water, and all vessels and utensils used in the room should be thoroughly washed with the same solution. All wash-bowls, water-closets, sinks, and slop-hoppers should be washed with a solution of chloride of lime (one half-pound to the gallon of water). When death occurs, the body should be immediately placed in the coffin, wrapped in a sheet saturated with a solution of corrosive sublimate (two drams to the gallon of water), and the coffin tightly and finally closed. No public funeral should ever take place at the house where the patient died, or elsewhere, unless the coffin remains hermetically sealed. Corrosive sublimate is a poison.

NORMAL MICROBES IN THE HUMAN STOMACH.—M. Abe-lous recently communicated to the Académie des Sciences the results of an investigation of the microbes of his own stomach. He succeeded in obtaining and studying no less than sixteen separate and distinct species. Of this number, seven have already been described, while nine appear to be new ones. The known ones are *Sarcina ventriculi*, *Bacillus pyocyaneus*, *Bacterium lactis aerogenes*, *B. subtilis*, *B. mycoides*, *B. amylobacter*, and *Vibrio rugula*. One of the unknown species was a coccus; the others were bacilli. Especial interest attaches to the function which Abelous believes

these micro-organisms perform in connection with digestion. Thus he found that 10 attack albumen, 12 fibrine, 9 gluten, 10 cause the more or less complete transformation of lactose into lactic acid, and 13 form variable quantities of glucose from starch.

ANATOMICAL AND PHYSIOLOGICAL MEMORANDA.—The following anatomical and physiological memoranda, which we copy from the *New York Medical Record*, will be of interest to our readers, and serve a useful purpose as a matter of reference: "In each respiration an adult inhales one pint of air. Man respire sixteen to twenty times a minute, or twenty thousand times a day; a child, twenty-five to thirty-five times a minute. While standing, the adult respiration is twenty-two; while lying, thirteen. The superficial surface of the lungs, i.e., of their alveolar spaces, is two hundred square yards. The amount of air inspired in twenty-four hours is ten thousand litres (about ten thousand quarts). The amount of oxygen absorbed in twenty-four hours is five hundred litres (744 grams); and the amount of carbonic-acid gas expired in the same time, four hundred litres (911.5 grams). Two-thirds of the oxygen absorbed in twenty-four hours is absorbed during the night-hours from 6 P.M. to 6 A.M. Three-fifths of the total CO₂ is thrown off in the day-time. The pulmonary surface gives off one hundred and fifty grams of water daily in the state of vapor. An adult must have at least three hundred and sixty litres of air an hour. The heart sends through the lungs eight hundred litres of blood hourly, and twenty thousand litres, or five thousand gallons, daily. The duration of inspiration is five-twelfths, of expiration seven-twelfths, of the whole respiratory act. During sleep, inspiration occupies ten-twelfths of the respiratory period."

LIME-BURNERS FREE FROM CONSUMPTION.—It is said that lime-burners are free from consumption. Halter has observed this in the Lengerich kilns. The temperature of the air inhaled at these kilns is 105° F. to 158° F., and to this Halter attributes the immunity of the lime-workers more than to anything else. He recommends for the treatment of consumption the inhalation of dry air heated to from 248° F. to 374° F. His theory is that the development of the bacilli is prevented by this high temperature.

AUSTRALIAN RABBIT-PEST.—The experiment of introducing the virus of chicken cholera into Australia, with the object of exterminating the rabbits which have become such a plague in that country, has proved a failure.

RHEUMATISM.—Dr. Terc contributes to the *Wiener Medicinische Presse* a novel method of curing rheumatism. He observed, that, when rheumatic persons were stung by bees, the swelling which usually follows such stings was very slow in appearing, and, if the persons were stung repeatedly, it did not appear at all; the result of such continued stinging being to cure the rheumatism, which showed no tendency to recur. He followed out this idea in the cases of 173 persons, 39,000 stings being required. Both acute and chronic cases were cured by this treatment.

ELECTRICAL NEWS.

The Discharge of a Leyden Jar.

DURING the past year, Professor O. J. Lodge has experimented and written a great deal on the subject of lightning-conductors. He has taken up the subject of electrical discharges, and has shown that many of our notions on the subject require modification. But the experiments he has made have been necessarily on a small scale, and, in applying his results directly to the problem of protection from lightning-discharges, he may be greatly in error. Still he has called attention to and stimulated inquiry on a subject of vital importance, and his work is already bearing fruit in the investigations begun by a number of other workers.

On March 8, Professor Lodge delivered a lecture at the Royal Institution of Great Britain, on the discharge of a Leyden jar. When such a jar is charged with electricity, and then the two coatings are discharged by connecting them by a short, thick wire, the result is not a single current of electricity along the wire in one direction, but the current passes back and forth, its intensity diminishing until it finally dies away and the jar is fully discharged.

This oscillation of the current was first observed by Joseph Henry, in 1842. He found that when the wire joining the two coatings of the jar was bent into a helix, and a needle placed inside, the magnetization of the needle due to the discharge-current was not always in the right direction. Henry stated that "the phenomenon requires us to admit the existence of a principal discharge in one direction, and then several reflex actions backward and forward, each more feeble than the preceding, until equilibrium is obtained." Later, Thomson worked out a mathematical theory of the subject, which agreed with Henry's observations; and further experiments have substantiated the results.

Professor Lodge showed experimentally, but on a small scale, a case of the resonance of two Leyden-jar discharges, by causing sparks in one circuit by the discharge of a jar in a neighboring one. Another interesting experiment was the rendering audible of a Leyden-jar discharge as a musical note. The period of the oscillation in an ordinary discharge is many million vibrations a second. But this can be reduced in two ways, — by adding to the capacity of the circuit; or by increasing its self-induction, as one would increase the flexibility of a spring, and then load it in order to increase its period. On adding more jars, and on increasing the self-induction of the circuit by putting in a coil of wire, the period was reduced until a shrill whistle resulted from the discharge; on adding another coil, the one lowered again until the pitch was about that of the highest note of a piano; another coil brought it down to the octave above the middle C. The noise of the spark which is ordinarily heard is due to the sudden heating of the air. If the heat is oscillatory, the sound will be oscillatory too; and, by reducing the period of the electric oscillation, we bring the sound within the limit of audibility. On analyzing the spark that produced the lowest note, by means of a rotating mirror, a coarsely serrated band was seen. Another interesting experiment was tried with the jar discharge. If a polarized ray of light be passed through a piece of heavy glass around which a current is passed, the plane of polarization is rotated. Instead of a steady current, Professor Lodge used the oscillatory current from the jar; and a similar effect was obtained, even when the period was less than one seventy-thousandth of a second.

In concluding, Professor Lodge said, "The present is an epoch of astonishing activity in physical science. Progress is a thing of months and weeks, almost of days. The long line of isolated ripples of past discovery seem blending into a mighty wave, on the crest of which one begins to discern some oncoming magnificent generalization. The suspense is becoming feverish, at times almost painful. One feels like a boy who has been long strumming on the silent keyboard of a deserted organ, into the chest of which an unseen power begins to blow a vivifying breath. Astonished, he now finds that the touch of a finger elicits a responsive note; and he hesitates, half delighted, half affrighted, lest he be deafened by the chords which it would seem he can now summon forth almost at will."

A NEW ALLOY. — A new alloy has been made by Herr Reith of Bockenheim, Germany, which is said practically to resist the attack of most acid and alkaline solutions. Its composition is as follows: copper, 15 parts; tin, 2.34 parts; lead, 1.82 parts; antimony, 1 part. The alloy is therefore a bronze with the addition of lead and antimony. The inventor claims that it can be very advantageously used in the laboratory to replace vessels or fittings of ebonite, vulcanite, or porcelain.

A SERIES ELECTRIC TRAMWAY IN ENGLAND. — There has recently been tried, near the Northfleet Station of the South-Eastern Railway in England, an experiment on a system of electric traction, which, in its practical realization, has been imported from the United States. Indeed, it is curious that while the English technical papers claim with some pride that the work is a "distinctly English invention, due to the late Professor Jenkin and Professors Ayrton and Perry," yet the invention apparently lay dormant until it was practically worked out by two Americans, — Short and Nesmith, — applied on an extended scale in the United States, and finally introduced into England by the corporation controlling their patents. The track used for the trial seems to be considered a specially difficult one, since it has on it a three-

per-cent grade four hundred yards long; but if we compare it with the average line in this country, where eight and even ten per cent grades are the rule rather than the exception, it would seem a very easy trial. The car was propelled by a single motor, sleeved to the axle and flexibly suspended, according to the system introduced by Sprague. Current was supplied from a conductor carried in a conduit. The novel feature of the system lies in the fact that the cars are worked in "series" instead of in "parallel." This necessitates the interposition of the motors into the main line; and to effect this a special device is needed. In the main line, in the centre of the conduit, are a number of contacts made by two plates normally held together by springs. If these plates were pulled apart, the main circuit would be broken, unless at the same time some conducting circuit is joined across them. Attached to the car, and travelling in the conduit, is a long "arrow." There are metallic strips on either side of the "arrow," and between these strips is joined the circuit of the motor. As the car moves along, the "arrow" passes between the contact-plates, forcing them apart, and thereby introducing the motor into the main circuit. On passing through a distance equal to the length of the "arrow," another set of contact-plates is forced apart, while the set which is left closes, thus keeping the circuit intact. On the trial the system worked well, and every one was well satisfied, as is usually the case at an exhibition of a new system. It should be remembered, however, that in this country the system has not been uniformly successful. At Denver a great deal of trouble was experienced, to the detriment of electric traction in that section of the country, and the system is not being rapidly introduced. The large number of contacts required, the possibility of some of them failing, the great danger of burning out the motors, with other possible objections, tend to make an unfavorable comparison with systems of greater simplicity.

THE PRICE OF COPPER. — The collapse of the copper syndicate should have an excellent effect on the extension of electric lighting and power distribution. The high price that has ruled in the last year has been very unfavorable to electric-light people, especially those using the low-tension system of distribution. It is to be hoped, however, that the change in the cost of copper will not bring up again the fierce discussions as to the relative merits of high and low potential distributions which ruled about a year ago. We can expect, however, that this year will see more than double the amount of plant installed than did last year.

NOTES AND NEWS.

SEVERAL large textile manufacturers of Paterson and other manufacturing centres are reported by *Bradstreet's* to be inaugurating a movement for the founding of a textile technical school. The object of the movement is threefold, — to elevate the character and improve the style of the American fabrics, to render the domestic manufacturers independent of European art and skill in the production of high-grade goods, and to secure independence of trades-unions. Negotiations are reported to have already been opened with qualified teachers from abroad to assume charge.

— As summer approaches, and so many of our readers are considering the possibility of spending some of their vacation time in Europe, it may be well for them to investigate the merits of the Cheque Bank as a custodian of their funds while travelling. This institution was established seventeen years ago in London, for the convenience of the travelling public, and numbers among its trustees some well-known men. The bank aims to furnish the traveller with an immediately available security equal in value to a Bank of England note, only safer to carry. Letters of credit are done away with, while upwards of two thousand banks and bankers throughout Europe are now cashing the checks issued by the Cheque Bank. The British Government accepts them in settlement of customs charges, and railroad companies frequently accept them in payment of fares, as do also hotels and store-keepers in some cases. The bank issues check-books, each containing ten checks, which can be drawn for any amount the purchaser may desire. A branch office has recently been opened in New York under the management of Messrs. E. J. Mathews & Co., at No. 2 Wall Street.

SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

PUBLISHED BY

N. D. C. HODGES,

47 LAFAYETTE PLACE, NEW YORK.

SUBSCRIPTIONS.—United States and Canada.....\$3.50 a year.
Great Britain and Europe..... 4.50 a year.

Science Club-rates for the United States and Canada (in one remittance):

1	subscription	1 year.....	\$ 3.50
2	"	1 year.....	6.00
3	"	1 year.....	8.00
4	"	1 year.....	10.00

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VOL. XIII.

NEW YORK, APRIL 5, 1889.

No. 322.

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THE ISSUE OF THE *Publishers' Weekly* for March 30 contains the spring announcements of American publishing-houses. This list shows comparatively few books of importance, — a fact very likely due to the tendency, on the part of the trade, to put off their best things and postpone their best efforts until fall. This has come about through the custom, at present prevailing in this country, of buying books only through one or two months in the year, which has led to a considerable demoralization of the trade of book-making. There are now in America sixty millions of people, using one language, the most of them able to read, and, on the average, more able to buy books than the people of any other country. The trade in reading-matter is certainly enormous, but it is largely confined to newspapers and periodicals; the newspapers especially growing bigger and bigger, until their Sunday issues supply for three or four cents more than a day's reading. For the time being they monopolize a great part of the reading-time of the week, and lessen in this manner the time available for books. Yet, taking all this into consideration, and remembering that in the thirty years since 1859 our population has more than doubled, and the proportion of illiteracy has decreased, there ought to be a great demand still left for books. There are certainly a large number of cheap editions supplied through the dry-goods dealers and similar channels of distribution; but it remains that the book-market is not of as high a class as was that of a generation ago. Just before

the war several of the existing houses and the predecessors of existing houses in New York, Boston, and Philadelphia, were almost at the culmination of their prosperity; and, besides these, there were a number of other publishing-houses of note or respectability whose names are honorable in the history of literature. It would be difficult to find now any publisher who would undertake at his own risk the issue of the many standard series of books which were so creditable to American book-production of thirty years back.

Publishers find in the present state of American literature little to encourage them; authors find in the present state of American literature little to encourage them. The largest houses are unwilling to take the risks which a generation ago their fathers in the business would have taken. The retailers of books have certainly not increased in number, and have apparently decreased. Take, for instance, the city of Salem, Mass., the home of Hawthorne, Prescott, Bowditch, and of many others who have made American literature famous, — a place whence some of the noted publishers in the American trade found their way to Boston and other places, a city of great intellectual activity. In old days it was well supplied with retail stores, some of which grew to be publishing-houses. The book-trade of Salem has not been displaced by a free public library. It is only within the last year or two that such an institution has been started. Yet only one book-store of any importance remains in Salem, and that is largely devoted to the sale of wall-papers, etc., and expects rather to take orders than to carry any considerable amount of standard books in stock. The live book-trade has gone almost entirely into the hands of an enterprising dry-goods house, who are members of the Syndicate Trading Company, and who handle at Christmas time and throughout the year a considerable quantity of books, but could scarcely be relied upon to perform the functions of the old-fashioned book-store, with its supply of standards on the shelves, tempting a customer to increase his library with books that are books. It can scarcely be said that the retail trade has gone to Boston, for the trade of Boston is not so wonderfully larger than it was in old times; and this state of things is more or less true throughout the country. Book-selling and book-buying have both suffered a decadence in quality as well as in quantity, except in the case of books of exceptional popularity. The size of editions is scarcely larger, if as large, as in the days when we had not a third of our present reading population.

ALUMINIUM AND ITS MANUFACTURE BY THE DEVILLE-CASTNER PROCESS.

ALUMINIUM was shown to be a distinct substance in 1754 by Marggraff. It may be ranked among the noble metals, because it does not tarnish, even when exposed to damp and very impure atmospheres; and until lately it was almost a precious metal, the price ranging as high as 60 shillings per pound. Indeed, even now, absolutely pure aluminium is scarcely to be obtained, the metal used in the arts being contaminated with from two to five per cent of iron, silicon, and other substances. The chemical symbol of aluminium is Al: its atomic weight is 27.4. Aluminium is very widely diffused over the earth. Its silicate forms the chief constituent of clays, and enters into the composition of a vast number of minerals, especially of felspars. Its fluoride, united with that of sodium, forms cryolite. A ferruginous hydrate is known as bauxite, and forms probably the most convenient ore from which to extract the metal.

The method now generally adopted in preparing aluminium was discovered early in this century by the eminent French chemist, Henri Saint-Claire Deville, and consists in reducing the double chloride of aluminium and sodium ($2\text{NaClAl}_2\text{Cl}_6$) by means of metallic sodium at a high temperature. The manufacture, therefore, resolves itself naturally into two parallel processes; the one comprising the preparation of the double chloride, and the other the production of metallic sodium. As sodium to the extent of nearly three times the weight of aluminium is required in the re-

duction of the latter metal, it will be seen that the cheapness and abundance of the aluminium depends very much on the cost of the sodium, and the quantity in which it can be produced. Till quite recently, the price of sodium was as high as 5 shillings a pound; and the process of manufacture was so difficult, and even dangerous, that very large quantities could not be obtained. The improvements effected by Mr. Hamilton Y. Castner in the manufacture of sodium, by which it can be made in any quantity without the slightest risk at about 1 shilling per pound, has rendered it possible to produce aluminium of about 98 per cent purity which can be sold profitably at 20 shillings per pound.

The object of a paper by William Anderson, in a recent number of the *Journal of the Society of Arts*, London, is to describe the process of manufacture adopted by the Aluminium Company, at the works, which have just been started, at Oldbury, near Birmingham.

We will first take the manufacture of the double chloride of aluminium and sodium. The raw material is hydrate of alumina ($\text{Al}_2\text{O}_3 + \text{water}$), which is the only oxide of aluminium. It can be prepared in a variety of ways, and from various materials, such as common alum, which is the double sulphate of aluminium and potassium, $\text{Al K}(\text{SO}_4) 12 \text{H}_2\text{O}$; bauxite, which, as already stated, is a ferruginous hydrate; and other substances; the price being about £13 per ton when it is sufficiently pure for the purpose.

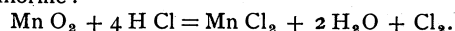
The hydrate of alumina, in a finely divided state, is mixed, on a suitable floor, with lamp-black, charcoal, and common salt; moistened with water; the mass is thrown into a pug-mill, and, after being thoroughly mixed and incorporated, is forced through dies constructed exactly as in a drain-pipe machine, the issuing cylinders of the compound being cut off by wires into pieces about three inches long, which are carried to the tops of the chloride furnaces, and spread out there to dry thoroughly.

The next process is to expose the mixture of hydrate of alumina, carbon, and salt, to a high temperature in presence of chlorine gas, in order to obtain the vapor of the double chloride, which is distilled over, and condensed in the form of a deliquescent, light-yellow substance of very pungent odor. This operation is performed in regenerative furnaces, constructed very like banks of ordinary earthenware gas-retorts. The gas from the producers plays round groups of five retorts, set in ovens, in which their temperature is raised to a bright-red heat, the exact intensity of which is a matter of much importance, and requires an experienced eye to regulate.

The retorts are connected at their mouths — that is, their opening ends — by means of earthenware pipes to gas-holders containing chlorine gas, special means being taken to regulate the pressure of the gas and the rate at which it is allowed to flow. The opposite ends of the retorts are fitted with pipes, which convey the fumes of double chloride to cast-iron condensers, and thence to brick chests or boxes, the outsides or ends of which are closed by means of wooden doors. Convenient openings are arranged for clearing out the passages, because the double chloride condenses very quickly. The greater portion of it liquefies, and trickles down into the brick chambers; while a portion sublimates, and comes over in the form of a yellow powder. The brick chambers are emptied from time to time, and the contents packed away in air-tight wooden chests, — a precaution rendered necessary on account of the deliquescent properties of the substance. The re-action which takes place is as follows: —

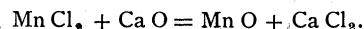
$2 \text{Al}_2\text{O}_3 + 3 \text{C} + 4 \text{Na Cl} + 6 \text{Cl}_2 = 2 (\text{Al}_2\text{Cl}_6 + 2 \text{Na Cl}) + 6 \text{CO}$.
That is, two molecules of alumina, three molecules of carbon, four molecules of salt, and six molecules of chlorine, give two molecules of double chloride and six molecules of carbonic oxide.

The chlorine gas used in the retorts is manufactured on an enormous scale, being prepared in the usual way, by the action of hydrochloric acid on manganese dioxide, at a moderately high temperature. One molecule of the manganese dioxide combining with four molecules of hydrochloric acid, produces one molecule of manganous chloride, two molecules of water, and one molecule of gaseous chlorine: —



The manganous chloride is soluble, and forms the "spent still liquor," which is reconverted into manganese dioxide by Weldon's

method; that is, by first neutralizing all free hydrochloric acid by means of powdered limestone, and then adding milk of lime to the neutral solution, when manganous oxide and calcic chloride are formed: —



By exposing the manganous oxide to a strong current of air, it takes up another atom of oxygen, and becomes again Mn O_2 , or manganese dioxide.

The chlorine plant forms a very imposing part of the factory. The hydrochloric acid is conveyed by a 2-inch gutta-percha pipe a distance of some 700 feet across the canal, from Messrs. Chance Brothers' Alkali Works. It is received into six large stone storage-tanks, each capable of containing 10 tons; and from these it is run, as it is wanted, into two large stone stills made up of huge slabs of sandstone cramped together in an ingenious manner by iron bolts and cast-iron angle saddles, the joints being made by means of solid India-rubber cord. In these stills the manganese dioxide and the acid are mixed; and, being warmed by injected steam to the proper temperature, the chlorine gas is at first given off rapidly and with effervescence. The rate gradually decreases, and at length the disengagement of gas ceases altogether. The chlorine is carried off by means of lead and earthenware pipes to four large lead-lined gas-holders, capable of containing several thousand cubic feet of gas; and from them it is led away to the double chloride retorts, various ingenious devices having been introduced for indicating the pressure of the gas, and measuring the quantity passed into each retort. Chlorine, besides being valuable, is a very disagreeable gas when it gets out of its proper place: hence great care and method are required in manipulating it.

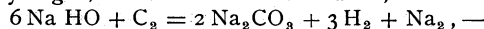
The "spent still liquor," the solution of manganous chloride, is run into a large neutralizing well, 20 feet diameter, and 20 feet deep, built of stone, and fitted with agitators. It is there neutralized by intimate mixture with powdered limestone, and is allowed to settle, after having been pumped up to a system of tanks elevated above the oxidizing-tower, during which process iron and some other impurities are carried down. The clear solution, which has a pinkish color, is then run into the oxidizing-tower, which is a wrought-iron cylinder standing on end, about 12 feet diameter and 30 feet high, where it is warmed by injected steam. Milk of lime is added, and the whole violently agitated by a powerful current of air, pumped in at the bottom of the tower by an 80-horse-power horizontal engine driving a large double-acting air-pump. In two or three hours the manganous oxide has absorbed as much oxygen from the air-current as it had at first given up to the hydrogen of the hydrochloric acid, and thus reverts to its original state.

The contents of the tower, now a thick black turbid liquid, are run into a second system of settling-tanks, five in number, erected below the level of the tower. The tanks are each 18 feet square by 7 feet deep, and are used alternately for settling the charges as they are withdrawn from the tower. The recovered manganese dioxide settles out, leaving a clear solution of chloride of calcium, which is drawn off by overflow pipes; and the recovery process is then complete, the manganese mud being thus used over and over again, and re-recovered, suffering but an inconsiderable amount of loss in the process.

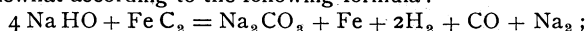
We next come to the manufacture of sodium. Previous to the year 1886, sodium was produced by reducing it from the hydrate or carbonate of soda by heating it to a very high temperature, with an excess of carbon, great care being taken to avoid fusion of the mass, to which end lime was added. Fusion was prejudicial to the process, because, when fused, the carbon separated from the alkali, and only a small return was obtained: hence the temperature had to be carried sufficiently high for the alkalis to be volatilized, because only in that form could the soda compounds come into sufficiently intimate contact with the carbon for its combination with the oxygen of the alkali to take place, and set the metallic sodium free. The high temperature required caused great wear and tear of the iron retorts in which the process had to be carried on, and dangerous explosions were not uncommon; the practical effect being that the production of sodium was very limited in quantity, and the price, as already stated, ranged as high as 5 shillings per pound.

Mr. Castner, a chemical engineer of New York, became pos-

sessed of the idea, that, if suitable means were discovered, it would be possible to reduce the sodium and potassium compounds at a much lower temperature by bringing the carbon into intimate contact with the alkalis in a molten condition. If six molecules of the hydrated oxide of sodium, commonly called caustic soda, be added to one molecule of carbon, it will yield, when heated to a high temperature, two molecules of carbonate of soda, three molecules of hydrogen, and one molecule of sodium, —



and the reduction will take place in an atmosphere of hydrogen, provided that a sufficiently intimate contact can be secured between the carbon and the alkali. Mr. Castner's process to attain this end, arrived at after a couple of years of patient experiment, is partly mechanical and partly chemical. He prepares an artificial carbide of iron by coking an intimate mixture of finely divided iron and pitch, or other hydrocarbon; the result being a heavy metalliferous coke, which, when ground fine and mixed with caustic soda in the fused condition, blends intimately with it, and causes the reduction of the soda at a temperature very much below that hitherto found possible, namely, below that of melting silver, which has been estimated to be about 1000°C . The chemical re-action during reduction cannot be confidently defined, but it probably is somewhat according to the following formula: —



that is to say, four molecules of caustic soda and one molecule of the carbide of iron, as above defined, produce, in the liquid form, one molecule of carbonate of soda and one atom of iron; while two molecules of hydrogen, one molecule of carbonic oxide, and one molecule of sodium, escape in the gaseous state. The hydrogen and the carbonic oxide ignite, and burn with a brilliant flame colored by the characteristic sodium hue, while the sodium distils, and condenses into suitable vessels. The reduction thus takes place in an abundant atmosphere of hydrogen and carbonic oxide, which effectually preserves the sodium from oxidation till it can be safely deposited in mineral oil.

The apparatus for preparing the sodium is sufficiently simple. The caustic soda is received in drums from the neighboring alkali works of Messrs. Chance Brothers. The finely divided iron is mixed with melted pitch in iron pots set in a suitable stove, and the mixture of pitch and iron is then calcined into coke in large iron retorts set in an ordinary furnace.

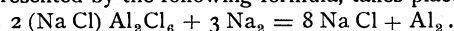
The metalliferous coke is ground into a fine powder by means of ordinary edge-runners, and is ready for charging into the sodium-retorts, which are of specially ingenious construction, and deserve a detailed description. Each furnace is heated by gas, applied on the regenerative principle, and contains five cast-steel crucibles, or pots of an egg-shaped form, arranged with their long axes vertical. The upper part of the egg is formed into the head or cover, much like the artificial Easter eggs which contain sweets; but it is fitted with a vertical pipe, which passes up through the top of the furnace, and forms the passage by which a portion of the charge is introduced, and it also has a lateral branch connected to the condenser, which consists of a small cast-iron vessel of peculiar form, arranged so as to allow the fluid sodium to trickle out, to let the hydrogen and carbonic-oxide gases escape, and to afford facilities for cleaning the passage, so as to prevent it from becoming choked. The form of this condenser is of some importance, if the best results are to be obtained. The whole of the head above described is secured immovably in the upper part of the furnace, and is protected by the oven-setting from extreme heat; it can, however, be readily removed if desired. The lower part of each retort rests on the top of a vertical hydraulic lift, which is worked by a moderate water-pressure, provided by a special duplex pump; and it is this pressure, which, with the interposition of some luting, forms the joint between the head of the retort and its lower portion. The upper part of the lift or platform is so arranged, that, when the retort resting on it is in its place, the aperture in the bottom of the furnace is completely closed. When the lift is lowered, the bottom half of the crucible sinks to the floor level; and a two-wheeled iron hand-truck of special construction is wheeled up, and catching hold of the crucible by two projections on its sides, provided for the purpose, lifts it off the hydraulic ram, and by the aid of two men transports it to the "dumping" pits, on the edge of which it is

turned on its side; the liquid carbonate of soda and finely divided iron, which form the residue, are turned out; and the inside is scraped clean from the opposite side of the pit, under the protection of iron shields. When clean inside and out, the crucible is again lifted by the truck, and carried back to the furnace, receiving a portion of the fresh charge on its way. It is then again placed on its ram and lifted to its place, having still retained a good red heat. It takes two minutes only to remove and clear a crucible; from six to eight minutes performs the same office for the set of five; and the whole cycle of operations, including the distilling of the sodium, requires one hour and fifteen minutes. The five crucibles yield 500 pounds of sodium per twenty-four hours; so that the battery of four furnaces is competent to yield 2,000 pounds, or nearly one ton, of sodium per day.

The only portions of this plant liable to exceptional wear are the bottom halves of the crucibles, the durability of which is found to depend very much on the soundness of the cast steel of which they are made, because any pores or hollows are rapidly searched out by the furnace flames. The average duration of each crucible at present is about 750 pounds of sodium, or 125 charges. The carbonate of soda removed from the retorts is returned to the alkali-makers, and is again converted into caustic soda, fit for further use.

The six pounds of sodium, the produce of each charge, is allowed to trickle from the condensers into small iron pots, in which, when cool enough, it is covered with mineral oil, and then transported to the sodium-store, where it is melted in large pots, which are heated by an oil bath, and cast into ingots of convenient form for the subsequent operations. The strong affinity of sodium for oxygen is well known: hence it is best kept covered by an oil, such as mineral oil, which does not contain oxygen in its composition; and the greatest care has to be taken to protect it from water, because water is decomposed with so much energy by sodium, that the heat caused by the clashing-together of the atoms of sodium and the oxygen of the water is sufficient to ignite the liberated hydrogen. Hence the apparent paradox, that, to make the sodium-store fireproof, it is necessary to make it waterproof also, and at the same time to avoid naked lights, which may chance to set the vapor from the oil on fire.

We have now got the two ingredients required for the production of aluminium; namely, the double chloride of aluminium and sodium, and metallic sodium. The double chloride is broken into small pieces, and mixed with cryolite (the native fluoride of aluminium and sodium, $6 \text{Na F Al}^2\text{F}$), and with metallic sodium cut into thin slices by an ordinary tobacco-cutting machine. The mixture is tightly enclosed in a revolving wooden box, in which it gets thoroughly mixed. This part of the process is somewhat trying, on account of the hydrochloric-acid gas given off by the double chloride, which slowly decomposes when exposed to the air. When the ingredients are sufficiently mixed, they are turned out on to the hearth of a regenerative reverberatory furnace, over which the mixing cylinder is placed. The hearth is made to slope towards a lateral opening, which is closed during the process of reduction by clay, supported by iron plates and keys. There are two furnaces, — a small one, capable of producing 60 pounds of aluminium per charge; and a large one, which yields 140 pounds. The charge introduced into the furnace melts quickly; and a reaction, represented by the following formula, takes place: —



That is to say, one molecule of the double chloride and three molecules of sodium yield eight molecules of common salt and one molecule of aluminium. The process of reduction lasts about three hours. The melted slag, which consists chiefly of common salt and the cryolite (which merely served as a flux), is drawn off by breaking the clay stopping of the hearth-opening from above downwards; and finally the lower tapping-hole is broken through, and a silvery stream of metallic aluminium runs out, and is received into cast-iron moulds. The reducing operation requires considerable skill, and great attention to the temperature of the furnace, which has to be varied during the continuance of the re-action.

The large furnace is competent to produce 840 pounds of aluminium per day of twenty-four hours; and the small one, 360 pounds.

The first portion of metal which runs out, and which forms rather more than three-fourths of the charge, is of the greatest purity; the remainder, which has to be scraped off the hearth, or which gets entangled in the slag, and has to be subsequently separated out, contains a larger proportion of foreign substances. The cause of the difficulty in obtaining the separation of the metal from its slag consists in the very low specific gravity of aluminium.

The metal is now taken to the casting-house, arranged like an ordinary brass foundry, is remelted in plumbago crucibles, and cast into ingots, plates, or bars for subsequent sale or manufacture.

It is evidently impossible to here enter into all the details of manufacture, although these details are of the highest importance in obtaining commercially valuable results. Day by day, as the manufacture progresses, improvements are made which either enhance the economy of production or increase the purity of the sodium or aluminium produced. Such improvements in details cannot very well be made public till their value is thoroughly ascertained, and the protection of the patent law obtained when considered necessary.

The following table gives the quantities of the several ingredients employed to make one ton of aluminium:—

Metallic sodium.....	6,300 lbs.
Double chloride.....	22,400 "
Cryolite.....	8,000 "
Coal.....	8 tons.

To produce 6,300 pounds of sodium are required—

Caustic soda.....	44,000 lbs.
Carbide made from pitch (12,000 lbs.) and iron turnings (1,000 lbs.).....	7,000 "
Crucible castings.....	2½ tons.
Coal.....	75 "

For the production of 22,400 pounds double chloride are required—

Common salt.....	8,000 lbs.
Alumina hydrate.....	11,000 "
Chlorine gas.....	15,000 "
Coal.....	180 tons.

For the production of 15,000 pounds of chlorine gas are required—

Hydrochloric acid.....	180,000 lbs.
Limestone dust.....	15,000 "
Lime.....	30,000 "
Loss of manganese.....	1,000 "

The works are constructed so as to produce 1½ tons of aluminium per week: the quantities of the ingredients consumed are consequently half as much again as the figures given in the table. It is easy to see, therefore, that the factory must be on a very large scale; and the brief account of the process here given indicates also how complicated the manufacture is, and how much care and skill are necessary to conduct it successfully, if pure aluminium is to be made. The great enemies of the metal are iron and silicon, especially the former. When once it gets in, it is impossible to get it out again by any commercially practicable means: hence every precaution has to be taken to insure the purity of the materials; to which end a well-appointed laboratory, presided over by Mr. Baker, a very able chemist, is kept in active operation.

Aluminium is endowed with several remarkable properties. It is the lightest of the metals which possess considerable tenacity and hardness. A given volume of aluminium is only a little more than 2½ times (2.65) the weight of an equal bulk of water; whereas iron is 7½ times, copper nearly 9 times, gold 19½ times, and platinum 21½ times, as heavy as water. The metal has a bright silvery lustre. It is capable of taking a very high polish, and of retaining its brilliancy and color under conditions which would rapidly tarnish silver, because it does not oxidize from exposure to either dry or damp air, and is unaffected by that great enemy of silver, sulphuretted hydrogen, or other sulphur compounds present in London fogs, either at ordinary temperatures or even at a red heat. At ordinary temperatures it is not affected by either strong or diluted nitric acid. Weak sulphuric acid has no action on it, neither have sulphuretted hydrogen or sulphide of ammonium, which explains the reason why it does not tarnish, even in very impure atmospheres. Water has no effect on pure aluminium under ordinary

conditions; but, if it be made the oxygen pole of a galvanic battery, it is readily converted into alumina, forming a copious white precipitate. The vegetable acids, such as acetic and tartaric, have no effect: hence aluminium is admirably fitted for making into cooking utensils, coffee-pots, teapots, etc., its extreme lightness being also an advantage for this purpose. It is not acted upon by the hydrates of potassium and sodium in a state of fusion; but solutions of these alkalies in water dissolve it readily, forming aluminates of potassium and sodium, with evolution of hydrogen. Of this property the silversmith takes advantage in producing very beautiful frosted effects, by plunging the polished metal for an instant into a weak solution of caustic soda, washing in a large quantity of water, and then digesting in strong nitric acid. Its powers of conducting heat are high in the scale, being about two-thirds that of copper; its specific heat is .22, only lithium, sodium, and magnesium being above it. Its electrical conductivity is eight times higher than that of iron, and about equal to that of silver. Its elasticity and tenacity are equal to that of silver, and have been determined by Mr. W. H. Barlow at about 12 tons per square inch; but weight for weight, its tenacity would be the same as high-class steel, or 36 tons per square inch, that is to say, bars of equal weight would carry the same loads. Experiments on very fine wire have given the same results. It is very malleable and ductile, when proper attention is paid to annealing during the process of working,—a precaution common to the manipulation of most metals. Aluminium of about 97 per cent to 98 per cent purity may be rolled into thin sheets, and may be beaten into foil as thin as any that can be produced from silver and gold. It can be drawn into very fine wire, of only one-tenth of a millimetre diameter, and ought to supersede silver in the manufacture of metallic braid and tissues, because it will never tarnish as silver does. It can be stamped or spun into hollow ware, but there is as yet some difficulty in soldering it; at any rate, the process of performing the operation is known to very few people.

Aluminium forms alloys with most metals. Iron is always more or less associated with it; but it seems doubtful whether it be a true alloy, or wholly or in part a mixture, like the carbon contained in cast iron and in steel. Silicon is also invariably found associated more or less with the metal. Aluminium added to molten iron and steel lowers their melting-points, and consequently increases the fluidity of the metal, and causes it to run easily into moulds and set there, without intrapping air and other gases, and forming blow-holes and similar imperfections. It is in consequence used to the extent of about ½ per cent and less by some steel founders, and seems to render the production of sound steel castings more certain and easy. Admiral Kolokolzoff, the director of the great gun-factory near St. Petersburg, uses ferro-aluminium,—an alloy with iron, containing 10 per cent of aluminium,—and adds it to the crucibles of melted steel about ten minutes before pouring, in the proportion of one pound of the alloy to 80 pounds of steel, which gives one part in 800 of pure aluminium; and the result is that he gets the largest steel castings, completely free from air-bubbles, and with very excellent mechanical properties.

One of the most remarkable applications of the property which aluminium possesses of lowering the melting-point of metals has been made by Mr. Nordenfelt, in the production of castings of pure iron; that is to say, iron free from any sensible quantity of carbon or manganese. Pure iron melts at about the same temperature as platinum, that is, about 1700° C.; yet even then the molten mass is not liquid enough to be run into moulds, but the addition of from $\frac{1}{100}$ to $\frac{1}{700}$ part by weight, of aluminium, lowers the melting-point to such an extent that it becomes fluid enough to run into the most minute and intricate forms. Mr. Nordenfelt has given the name of "mitis" (flexible ductile) to his metal. Mr. Anderson then called attention to a wire brush of solid casting, the back and iron bristles forming one mass, and yet the bristles may be bent about just like the softest iron wire.

The process of manufacture is as follows: Wrought iron is placed in crucibles, which are put into a liquid-fuel air-furnace of peculiar and ingenious construction. In a furnace for six crucibles, for example, they are arranged on an elongated hearth in pairs, cross partition walls being so built as to cause the flame to embrace each crucible thoroughly. In the roof of the furnace are

openings, covered by movable, brick-lined plates, or doors, through which the crucibles can be got at. The flame playing over the hearth is conveyed by a short flue, fitted with a damper, to the chimney. Under the hearth is another flue communicating with the furnace, and also leading to the chimney, and fitted with a damper. By manipulating the two dampers, the flame may be directed either under or over the hearth at pleasure. The furnace proper is at the end of the hearth farthest from the chimney, and consists of a peculiarly constructed apparatus, whereby the cheap residues resulting from the distillation of kerosene, or the heavy oils obtained from gas-works, can be burned with the ordinary chimney-draught, and a most intense heat produced. The pair of crucibles next the furnace are the most highly heated. The metal in them melts first, and, as soon as the crucibles are removed for pouring, the remaining four are moved up near the flame, and two freshly charged ones put in at the end nearest the chimney, by which means most of the heat produced by the combustion of the fuel is utilized. As soon as the iron is fairly melted, but not overheated, aluminium is added, when the charge instantly becomes quite fluid, and fit for pouring, the lowering of the melting-point having had the same effect as superheating the metal.

The mits castings possess all the properties of the best forged iron, the tensile strength ranging as high as 27 tons per square inch, with an elongation of 20 per cent. The metal can be worked and welded just like wrought iron, and in fact cannot be distinguished from it, except that it is perfectly homogeneous and free from stratification.

When aluminium is used in such small quantities, it is best to make a preliminary rich alloy with iron (say, one containing from 10 per cent to 25 per cent of aluminium), and then to add so much of the alloy to the charge in the crucibles as will give the desired proportion of the more costly metal. This is the more necessary on account of the extreme lightness of aluminium, which makes it reluctant to mix with a metal three times its specific weight.

Aluminium alloys readily with copper in all proportions, and constitutes the metal known as aluminium bronze. The usual proportion ranges from $2\frac{1}{2}$ to 10 per cent of aluminium; and it is probable that the bronzes resulting form true alloys or solutions, because the addition of the lighter metal causes a marked increase of temperature of the molten mass, indicating the existence of chemical re-action; and the bronzes may be melted frequently without changing the relative proportion of the constituent metals. The tenacity and rigidity of the copper are much enhanced; 10-per-cent alloys having sustained as much as 45 tons per square inch, with an ultimate extension of 25 per cent. It must be remembered, however, that, to obtain the best results, absolute purity, or, at any rate, fixity of composition, both in the copper and aluminium, must be insured. Failing that, very discordant and disappointing results will be arrived at. The aluminium alloys of copper, up to 10 per cent, can be forged, and rolled hot, and worked as readily as copper, proper precautions with respect to annealing being observed. The color of the aluminium bronzes approaches very nearly that of gold. The metal takes a high polish, and is less liable to tarnish than ordinary bronzes or than copper itself.

Aluminium forms alloys with most other metals; but they possess no practical value at present, and therefore need not be described.

A discussion followed, in which Mr. E. Riley said he had gone into this question many years ago, when Sir Lowthian Bell brought out his process, and he had some experience of the so-called alloys of aluminium, having had numerous samples submitted to him. He wished to ask whether the Aluminium Company had any process by which the aluminium could be got from clay. With regard to the result of the alloys, he thought that practically the alloy of copper had proved very satisfactory, but, when they came to analyze it, no aluminium was found, except, perhaps, a mere trace. Some mits castings were submitted to him a few years ago by Mr. Nordenfeldt, but he found no aluminium in them; and so it was in the so-called alloys. He had also had several samples from America. There was nothing more easy to find than aluminium, but it might be there were several things which could be confounded with it. As regarded the action of aluminium on metals, his view was that it took away the oxygen, and made the casting more solid. It

was important to the Aluminium Company to know whether any of the processes put forward really reduced alumina or not. It was not an easy matter to find small quantities of aluminium. He had had samples submitted to him which were said to contain $2\frac{1}{2}$ per cent, but he could only find a small trace. He believed that aluminium would be a very valuable adjunct in making steel castings, and it was now being used. He had seen samples of cast iron in which it had been used, and found the castings exceedingly good, besides showing a considerable amount of strength.

Mr. Jeans bore testimony to the admirable way in which the company's works were conducted, and considered they reflected great credit on the inventor. There was only one other system which had all at once been brought so near perfection by its inventor; viz., the Bessemer process. Having come into contact with people who were likely to use the metal, he thought the general impression was that it would prove a valuable adjunct to the various forms in which iron and steel were manufactured. It was said that it would be an important element in the production of steel castings; but he was afraid, from the limited quantity of steel castings produced in England, that it would not be largely used for that purpose for some time to come, though in the production of mits castings and the like it might be employed on a larger scale. Taking the production of pig-iron in the United Kingdom as about 7,500,000 tons a year, he should be disposed to say that rather more than 2,000,000 tons were employed in the production of Bessemer steel, 1,000,000 tons in the Siemens process, and 2,000,000 tons in the production of manufactured iron, leaving rather over 2,000,000 tons for castings and other purposes. The technical literature of this country, the Continent, and the United States for some time past, had teemed with references to the subject; and experiments had been made on a large scale, which indicated, that, for castings of every description, this metal was especially valuable. For some time it had been a disputed point how far aluminium was an important element in the production of steel. Professor Faraday undertook researches into the subject in connection with Wootz steel; but his conclusions were disputed by eminent chemists, who went over the same ground; and, if his memory served him accurately, Faraday considered the good properties of Wootz steel due to the fact that there was a small percentage of aluminium in it. There could be no question, from what they had seen that night, that there was a great future for the new metal in connection with the metallurgy of iron and steel; and the effect of the paper would be to throw a new light on the subject, and to inform the outside public of a matter which was of high scientific and commercial importance. He thought the time would come when those who used aluminium for alloying purposes would prefer to have a metal in the purest condition in which it could be produced, in order that they might infuse into the casting such a proportion of aluminium as they might deem to be essential for certain specific purposes. In that way the field in the future would belong to the process which could produce the purest aluminium.

Mr. Alexander Siemens was afraid he occupied the rather invidious position of finding fault with this very excellent process, which gave plenty of opportunities of allowing impurities to get into the aluminium. This fact was admitted in the paper. He had been asked by the inventor of a rival process to describe it, which might be done in a very few words. Mr. Grabau produced a fluoride of aluminium by certain means, and it was heated until it began to evaporate. When this temperature was attained, a suitable quantity of sodium was melted and poured into the vessel, which was lined with cryolite and cooled by water; and the heated fluoride of aluminium, in the form of powder, was thrown upon the melted sodium. Very violent re-action took place, and the heat generated by the re-action was great enough to melt the aluminium as well as the by-product. As soon as the re-action was complete, the whole molten mass could be poured out in suitable forms; the aluminium settled at the bottom, and the cryolite at the top. To obtain the fluoride of aluminium, Mr. Grabau used the cryolite, which he procured by the final re-action by putting the powdered cryolite into a solution of sulphate of aluminium. The re-action which took place between the sulphate of aluminium and the cryolite gave the aluminium fluoride. The solution was afterwards evaporated, and the residue was washed with water, which took out the sul-

phate of sodium, and left the aluminium fluoride ready to be reduced. The advantages of this process were that all the materials were treated at a comparatively low temperature. The vessel in which the aluminium fluoride was heated, as well as the vessel in which the re-action took place, was lined with cryolite, so that there was no danger of impurities being imported into the aluminium which was the result of the process. The low temperature was very much easier managed than the high temperatures of which Mr. Anderson had spoken.

On the chairman asking what temperature was necessary, Mr. Siemens replied about 900° (Celsius), just above a dull red. The process, of course, required the action of sodium, and the inventor was engaged in experimenting upon a new process to prepare this; but, as the necessary patents had not yet been taken, he was not at liberty to describe it in detail. At a short distance from Hanover the factory was at work producing aluminium on a commercial scale, though it was not on the magnificent scale of Mr. Castner's; but the process was extremely simple, and the extremely clever way in which the by-products were used promised exceedingly well for the process.

Mr. W. Bobby said it appeared from the tables that 263 pounds of coal were used to produce 1 pound of aluminium; and this, to his mind, seemed a very formidable figure. He was himself connected with a rival process for manufacturing aluminium, which was in practical work, by the use of the electric furnace. This process did not produce pure aluminium; but one of the great and important uses of aluminium was as an alloy. If you got a pure aluminium, it was an extremely light metal, and it was very difficult to alloy it with iron. In the Cowles process the aluminium was produced in the furnace, and it was alloyed with iron, and came out in the proportion of 12 or 16 per cent of aluminium to the entire mass of the product. The aluminium in the alloy may be considered pure, as we know the other constituents. It was reduced from a hard white clay known as bauxite. The interior of the furnace was 5 feet long and 2 feet deep. They had a dynamo, which gave a current at 60 volts of 5,000 ampères, and it was conveyed through the furnace by means of carbon electrodes. The charge of bauxite and broken iron was put into the furnace, which was luted with charcoal to resist the heat, the current was turned on, and in an hour and a half they tapped the furnace and got out the charge of alloy. In the mean time the bauxite had become reduced from the intense heat in the furnace. There was a certain admixture of carbon in the charge, which formed a resistance to the current, and enabled it to diffuse heat through the charge. About 200 pounds of aluminium were produced per day. In answer to the chairman's question as to the percentage of the silicon which the alloy of iron contains, he could not tell the exact percentage, but he knew it was not a large one. In the copper alloy, in making 10 per cent bronze, the percentage was about .5.

Mr. Oliver J. Williams asked whether Mr. Anderson knew any thing of Brin's aluminium process, which he understood produced aluminium alloy from clay at a very small cost.

Mr. Anderson, in reply to Mr. Riley, said that wrought iron had been cast into large ingots, and the Germans had a cast-wrought iron; but it was new to him to hear that small and delicate castings, such as those exhibited, had been made without the use of aluminium. He did not think it could be done. Bauxite was a species of clay, and they had to pick out a material which had the greatest purity. If you could get it at a reasonable price, it was better to use a pure material than one which was impure, and have to get out the impurities afterwards. In steel a fractional percentage of carbon made a wide difference in the quality. He was not surprised, therefore, to find that aluminium would produce wonderful effects in the quality of the casting, and yet be scarcely distinguishable in the product. He was sorry to hear from Mr. Jeans that aluminium was not likely to be used very extensively in steel castings, and thought he was mistaken in this respect.

Mr. Jeans said what he meant to say was that the quantity of steel castings made in England up to the present time was so small, that the quantity of aluminium to be used would be comparatively small, at any rate until the production of castings had extended.

Mr. Anderson said that the production of steel castings was

increasing immensely every day. Aluminium would be used for the following reason: that when one made a bad steel casting it was a desperate job to get rid of it. It was very important to be sure that the castings made were sound; and, when aluminium could be obtained pure, it would come very much into use. It was no use making impure aluminium. It was quite possible, with a little extra expense, to get aluminium containing only one per cent of impurity. French aluminium had had the pre-eminence in this respect up to the present, but the purity of the French material had not exceeded 98 per cent. If aluminium could be got at 99 per cent of purity, or even a little above this, it would be an invaluable material for the manufacture of fine wire for making into braid, as it did not tarnish. The process referred to by Mr. Siemens was a very interesting one, and the only objection to it was the use of cryolite. The Aluminium Company were doing their best to get rid of the use of cryolite.

Mr. Siemens said the cryolite was a by-product of the raw product; it was made from the sulphate of aluminium.

Mr. Anderson thought that any process which would produce the metal on a large scale, and cheaply, would be a great advantage. He was not aware that any aluminium was made of a greater purity than 98 per cent, or at a lower price than 40 shillings per pound. His paper had nothing to do with the electrical process for making aluminium alloy.

BOOK-REVIEWS.

Suggestive Therapeutics: a Treatise on the Nature and Uses of Hypnotism. By H. BERNHEIM, M.D. Tr. by Christian A. Herter, M.D. New York and London, Putnam. 8°. \$3.50.

HYPNOTISM is no longer a novelty. Its long apprenticeship among the charlatans has been served; the ill name it gained during the days when pretension took the place of proof has been outlived; its apparent contradiction to the recognized laws of physiology has been minimized, if not removed. It holds a recognized place as a psychological method, as an extension of the domain of medicine, as a most promising field of scientific psychological advance. However interesting would be the history of the steps by which this favorable change of aspect has been accomplished, it must for the present be dismissed with the remark that it was in France that the movement grew and prospered, and it is to French scientists that most of our knowledge is due. The object of Dr. Bernheim's work is to give an exposition of the present appearance of the topic, especially with reference to its application to practical medicine.

At the risk of repeating what is well known, it must be prefaced that students of hypnotism are divided into two camps,—the school of Paris, of which Dr. Charcot is the leader; and the school of Nancy, represented by Dr. Bernheim. The former recognize three stages of hypnotism marked by constant physiological characteristics, transition from the one to the other of which is obtained by physical means; they believe, too, in the action of the magnet upon hypnotic patients, regard the appearances in hysteria as typical of hypnotism, and in part lay claim to such abnormal effects as the action of drugs at a distance. The school of Nancy may be characterized as "suggestionists," for this is the keynote of their view. They regard the phenomena as psychical in origin, recognizing no physical effects except as they act upon the mind; and they see differences of degree in the various stages of hypnosis, but no sharp distinctions of kind; furthermore, they assimilate the appearances to natural sleep, repudiating all claims to supernatural effects.

In this work of Professor Bernheim's we have the best exposition of the Nancy school,—a view, it should be added, that is daily gaining ground, and has received the sanction of almost all the German, Swiss, and Italian investigators, who have critically examined both views. No work is better suited for translation into English; and, with the translation of Binet and Féré's "Animal Magnetism," the English reader is favorably situated for gaining a clear insight into this enticing study. The arrangement of the book is capable of improvement. After explaining the modes of producing the state, the various degrees of its intensity, the rôle of

memory in the process, a chapter is devoted to a rather miscellaneous description of the appearances in a typical subject. The relation of these facts to the influence of mind over body is next ably discussed, and this is followed by a study of suggestion in the waking state. Here the exposition is interrupted by a controversial chapter, and the course of thought again changed to afford room for a brief historical sketch. Theoretical considerations conclude the first portion of the work. Part II. consists of a careful analysis of over one hundred cases in which the curative effects of suggestion were illustrated, with some account of the nature of the action in such cases. These cases are derived from the most various types of disease, and prove, that, in the hands of a careful expert, this means of betterment and cure is most valuable. Instead of filling out the skeleton plan of the work just given, it may be more serviceable to the prospective reader to illustrate the chief results of this laborious study.

The hypnotic condition is found to be only a somewhat extreme case of natural sleep. Every night we place ourselves in an accustomed attitude, seek a monotonous course of ideas, and will to go to sleep. It is auto-hypnosis. In artificial hypnotism the sleeper remains subject to the control of an operator, because that is the dominating idea in going to sleep. From this it follows that no one can be hypnotized totally against his will: the patient must have some notion that something unusual is to happen. Time and again has an operator, unknown to the subject, willed the latter to sleep, but to no purpose. Just as in sleep the will is subdued but not extinguished, so in hypnotism the patient is not totally in the hands of the operator. An act shocking to the moral susceptibilities must be insisted upon, and repeatedly, before it is executed. Nor is the individuality of the subject lost. His past attainments are all that can be drawn upon: no new power is developed, but the hidden recesses of the unconscious are ransacked.

A distinctive point is the memory the subject retains of what was done during the hypnotic condition. In all the deeper stages, upon awakening, nothing is recalled: the interval is a complete blank. But Dr. Bernheim most ingeniously shows that the knowledge is latent only, not lost. By careful hinting, the subject can be made to recall all that happened; and, if a suggestion be given that he is to recall what happens, then remembrance is complete. It is at this stage that the medico-legal interest centres. The unconsciousness of the victim would be the safeguard of the criminal. Not only this, but a suggestion can be given that hours, days, or weeks after awakening, the subject is to commit some outrage, and insist that it was done of his own free choice. In some cases "retro-active" suggestions are possible. The subject is told that he has been a witness to certain acts. He assimilates the incident to his experiences, elaborates it, and is certain of his testimony. The Tisza-Esler affair is a case in point. The judicial complications arising from these facts have yet to be satisfactorily solved.

Hypnotism magnifies the action of the mind upon the body, shows that processes usually beyond voluntary control or influence can by extreme attention be psychically influenced, wounds can be made and cured, the pulse be slowed or quickened, and even stigmata be produced. Here lies the essence of all the mind-cures; and it is only by a conscientious study of all such facts that mental healing can be placed upon a sound basis. Hypnotic cures act by keeping up a hopeful disposition, by focusing the attention on the object of cure, by dispelling worry, — all naturally efficacious processes. It is avowedly impotent in cases of organic lesion, but finds its special application in cases of impairment of nervous function.

Finally, hypnotism illustrates the extremely subtle steps of unconscious suggestion. The least change of facial expression, indicative of surprise, of gratification, of anxiety, is enough to give the clew to a sensitive subject. In this way many observers have been misled into attributing to physical or more mysterious influences what they have unconsciously suggested. This fact makes this field of study at once fascinating and treacherous. It requires peculiar talents and great shrewdness.

Such are a few of the main points which hypnotism has contributed to a scientific psychology. This contribution is of the greatest value, and especially when contrasted with the pernicious tendencies of the uncritical and sensational consideration of the same phenomena thereby displaced. While great credit is due to

Dr. Charcot and his associates for introducing the scientific era into hypnotism, and braving the contempt that such a step involved, equally great is the merit of the school of Nancy for relieving the phenomena of much of their mystery, and adding in every direction to our knowledge of these valuable conditions.

Natural Inheritance. By FRANCIS GALTON, F.R.S. London and New York, Macmillan. 8°. \$2.50.

MR. GALTON hardly needs an introduction to American readers. His researches into the heredity of genius, his study of the predominant traits of English scientists, his invention of composite photographs, together with a large number of interesting and original memoirs, have made his name and work known wherever new applications of scientific methods are appreciated. In the present work the author takes up the general problem of the processes of inheritance, upon special aspects of which he has expressed his views upon various occasions. His data are derived from entries according to the plan of the "Record of Family Faculties." This, it will be recalled, is a convenient book for the recording of the chief physical and mental characteristics of an individual, his parents and grandparents, his brothers and sisters, his own children, and so on. Prizes were offered for the most complete sets of such records; and from the answers to this competition for the prize, as well as from measurements taken at the Health Exhibition, Mr. Galton is able to deduce a few important and many subsidiary results.

A prominent feature in the present work is the application of the "probability curve" to the facts of physical variation, — an attempt to apply mathematical conceptions in the field of biology, and to found a science of biological statistics. We know that if a large number of men be measured, and the number of men between equal differences of height, let us say to each inch, be counted, the result will be somewhat as follows: the largest number of men will be found in the inch of height containing the exact average height of all the men measured, and to either side this number will very rapidly decrease as we depart from the average. What the probability curve does is to predict this rate of decrease, and to tell us how many men will be found at each degree of variation from the mean result. The test has been applied to quite a number of physiological characteristics, and with success; the numbers actually recorded, and those which the mathematical formula requires, being in fair agreement. Wherever phenomena depend for their exact appearance upon a large number of minute causes, no one of which has a considerable effect, this law seems to dominate. "It reigns with serenity and in complete self-effacement amidst the wildest confusion. The larger the mob, and the greater the apparent anarchy, the more perfect is its sway. It is the supreme law of unreason."

A point of particular interest in this curve is the point above and below which there is an equal number of measurements. This point — known as the probable error, because, if instead of measurements we were classifying errors, it would be the error we as often exceed as fall short of — in a sense determines the entire curve, and the comparison of the probable errors of two homogeneous curves is all that is needed to show their complete similarity and difference. It is by such methods and comparisons that Mr. Galton reaches his results, and it is just because his results are founded on such careful and ingenious methods that they can be regarded as reliable and valuable.

The chief outcome of the inquiry is the establishment of the law of regression towards a mean. If we take the height of the father and the height of the mother multiplied by 1.08, — the ratio of male to female stature, — draw the mean between the two, and call this the height of the "mid-parent," then the height of the child will be nearer to the average of the race than the height of the mid-parent, and will be so in a constant ratio determined as one-third; that is, the child will, on the average, be one-third less exceptional than his mid-parent. It is found, too, that the difference between the heights of the father and mother is an unimportant factor; the children of parents differing much in height and those of parents very similar in height being the same, provided the average height of the parents be the same in the two cases. Upon this basis, Mr. Galton has constructed a device by which we set weights

at the points on a scale opposite the height of each parent, and read on another scale the most probable height of son and daughter, as well as the range of variation within and outside of which there is an even chance of his or her appearance.

At first sight, this law seems opposed to the current conceptions of heredity, by which like breeds like, and qualities gather strength as they are handed down from parent to child; but, while the tendencies of the two laws are opposed, this opposition is not a contradiction. There is still room for the appearance of qualities in families, because the exceptional father is still more likely than the mediocre one to have an exceptional son; only the chances are not in favor of having a son equally as exceptional as he himself is. This is true because the rate of regression towards the mean is a ratio, and affects all alike. However, owing to the far greater number of mediocre parents, it is more likely in a given case that an exceptional son is the exceptional child of "average" parents than the "average" of exceptional parents. The law tells heavily against the continued inheritance of particular traits, both beneficial and pernicious ones, and regards as typical the oft-observed decadence of eminent families.

The variations in eye-color, the presence or absence of the artistic temperament, — which is shown to be more prevalent in women than in men, — the tendency towards types of disease, are treated according to the same plan, and the assumption of the validity of the law is found to accord with the facts. Mr. Galton has even attempted an experimental verification. The seeds of sweet-peas differing in size were grown, and the numbers of resulting seeds of

each size were obtained, with the result that the seeds were less exceptional in size than the parent-seeds, and also in about the ratio of one-third.

Besides this chief result, the volume contains a number of minor studies, all of which will be of interest to students in various scientific pursuits. The effect of marriage selection in continuing individual traits; the distinction between traits that blend, such as the mulatto issue of black and white, and those that do not blend but exist side by side; the possible shifting of the average result by a general amelioration of the race; the means of defining quantitatively nearness of kinship, — these form some of the minor points discussed.

In leaving the volume, one is impressed with the great value of method in statistical work, with the power of mathematical treatment to give clearness to results, with the enormous labor necessary to obtain results in this definite form, and with the great possibilities that this study holds out to our posterity as a means of racial and social improvement.

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Publications received at Editor's Office, March 25-30.

ADAMS, R. C. Pioneer Pilh. The Gist of Lectures on Rationalism. New York, Truth Seeker Co. 99 p. 16°. 25 cents.
MIXTER, W. G. An Elementary Text-Book of Chemistry. New York, Wiley. 459 p. 12°. \$2.50.
STEVENSON, E. I. Janus. Chicago, New York, and San Francisco, Belford, Clarke, & Co. 182 p. 16°.
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— The latitude of the Detroit Observatory, Ann Arbor, Mich., has been determined by the Zenith telescope, and discussed by the method of least squares, by Ludovic Estes, Ph.D., of the University of Michigan. The results are published in pamphlet form by the author.

— P. Blakiston, Son, & Co., announce that the edition of "The Hygiene of the Nursery," by Louis Starr, M.D., is exhausted. A new edition is in press, and will be published about April 1. The author has taken this opportunity to rewrite certain parts of the work, and to make some additions.

— On or about April 6 will commence the publication of a weekly journal, devoted to the petroleum and natural-gas resources of the whole country, entitled *The Journal of Oil and Gas*. Situated midway between the great gas-fields of Pennsylvania, Ohio, and Indiana, and in the heart of Ohio oil-producing territory, with every facility for the publication of a first-class journal, the publishers (Fremont, O.) will spare no effort to make it the recognized authority on gas and oil matters.

— The admirers of "Little Lord Fauntleroy" will welcome the leading article in this month's *St. Nicholas*, by Mrs. Lillie, telling of little Elsie Leslie Lyde, the child who is now interpreting the character to New York audiences. There is an article meant for boys, and describing with drawings and pictures "Ancient and Modern Artillery," by Lieut. Hamilton, and (to thousands of competitors a most interesting feature) the report awarding prizes in the "King's Move" Puzzle.

LETTERS TO THE EDITOR.

*.*Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.
The editor will be glad to publish any queries consonant with the character of the journal.

Twenty copies of the number containing his communication will be furnished free to any correspondent on request.

The Robinson Anemometer.

IT seems likely that there are now to be some rather interesting developments in regard to the movement of this anemometer. As to the use of an equation for representing the relation between the wind-movement and travel of the cups, I think it a serious waste of labor. Even if we have the equation given in last *Science*, it cannot help us in obtaining the relation till we have solved it, and obtained a table or the figures given in my letter published in *Science* of March 15.

Professor Marvin's explanation of the effect of a uniform wind blowing across a whirler, upon which an anemometer is being tested, is very surprising and entirely untenable. The anemometer is certainly *not* going *with* the wind during one half of its revolution, and *against* it during the other half. Suppose we carry an anemometer on a locomotive due north, and a wind is blowing from the north: the velocity registered by the anemometer will be the sum of the two. But if the wind is from the south, the anemometer will record the difference between the two. If the wind blows either east or west, it will add its effect to the motion of the locomotive. We see, then, that, during less than one-fourth of the

revolution of the whirler, a uniform current will be balanced on opposite sides, but during more than two-fourths of the revolution the uniform current will act continuously in augmenting the anemometer travel; or, in other words, the anemometer will be accelerated during more than three-fourths of the rotation, and retarded during less than one-fourth of it. This also explains why the helioid anemometer used in England did not show variable results, as it had a vane to keep it normal to the wind: the effect of the wind would just be counterbalanced at opposite sides of the whirl, and there would be no acceleration, as in the case of the Robinson anemometer.

Professor Marvin raises an interesting question as to the theoretical behavior of the cups in an intermittent wind. It has generally been considered that while these cups never respond instantly to the wind, and continually lag behind while the wind is rising, yet their momentum keeps them up, and about counterbalances this lagging while the wind dies down. During the experiments with the whirling arm it occurred to me that the wind might have a different effect, and that it was necessary to make the final comparison in the open air.

On March 23 a comparison was made between the regular Signal Service anemometer, weighing sixteen ounces, and one with paper cone-shaped cups of about the same dimensions, and weighing two ounces and a half. The results were very surprising, as the paper cones gave very nearly twenty per cent less velocity than the spherical; also, with the lowest velocity, these cups gave relatively the least wind. On watching the cups, it was plain that this diminution occurred with a uniform wind as well as with an intermittent one. The cups were then weighted with lead to four times their previous weight, and there was no difference in the result, showing that the trouble was with the shape, and not with the lightness of the cups. Paper cups were then made of a spherical form; and these gave almost exactly the same velocity as the metallic cups, though having only one-seventh their weight. It was noticed, that, with the most intermittent wind, the paper cups gave the most increase, amounting in one case to eleven per cent over the metallic. The higher the wind, in general, the more nearly did these cups agree. We may rest satisfied, then, that the heavy metallic anemometer, instead of giving too much wind, really gives too little; and the more gusty the wind, the less the movement recorded by the heavy cups.

H. A. HAZEN.

Washington, D.C., March 30.

An Earthquake in Pennsylvania.

IT occurred to me that it might be of interest to the readers of *Science* to know that an earthquake occurred at this place, Lancaster City, Penn., on the 8th of March, at about 6 hours and 40 minutes P.M. This tremor was felt also at Harrisburg, York, Philadelphia, and Reading, as well as at many other places within the community of these places. Never having felt an earthquake-shock myself, it did not at once occur to me that this was really an earthquake, and therefore I did not at once take the time of its occurrence. That evening and the next morning I tried to find persons who did look at their time-pieces at the moment when it occurred in order to find the time as accurately as possible. Altogether, seven persons were found who claim to have looked at their watches when it occurred. Of these, two are quite different from the others, and must be considerably in error. But five of them agree fairly well. I compared each one of those time-pieces with my own, which was compared with the Scholl Observatory clock. Making in this way all possible corrections, the mean of the times was found to be 6 hours 40 $\frac{2}{3}$ minutes P.M., with a probable error of only about two-tenths of a minute. This is 75 Meridian time. If the tremor did not have too high a velocity, and similar observations have been gathered at other places, it may be possible to get an estimate of the velocity and direction of the shock.

The tremor or trembling of the earth, according to my estimate, lasted about ten seconds. A number of persons agree with this estimate. Others, however, insist that it lasted about fifty seconds, as actually noted by the watch. The direction of the tremor seemed to be in a line a little north of west to south of east. Others also give it as north and south.

JEFFERSON E. KERSHNER.

Lancaster, Penn., March 26.

Shall We Teach Geology?

PERHAPS Professor Winchell and his reviewer have said as much as is profitable on the points at issue between them, and yet I for one should feel sorry to have the discussion end precisely as "Reviewer" leaves it. We all gladly admit that the Roman Empire is a more interesting object of study than the "old red sandstone;" but how if a study of the "old red sandstone" helps us to understand the Roman Empire, in the first place by giving us a superior method of study, and then by teaching us something about the theatre upon which the Roman and other empires played their parts? And especially how if one is teaching children to whom the Roman Empire is very distant and very dead, while the "old red sandstone" crops out just before the schoolhouse door, and is so attractive and interesting to them that they often ask questions about it? Unquestionably, our national hero, when properly brought before the mind, is a more gracious figure than a plesiosaurus; and yet it is very easy to teach American history in such a way that one form shall seem to the children about as rigid and unstimulating as the other. If a plesiosaurus is just being exhumed in the neighborhood (it is proposed to teach children only the near and the attractive in nature), I am not sure but he will prove, for a few days at least, the more interesting object.

It seems to me that "Reviewer" is afraid of a word. Suppose we say nothing about geology, but simply give the children an opportunity, at proper times and in due measure, to vary their studies by some minute and careful examination of minerals, plants, and animals. Such study need take but little time, but, if properly directed, may be very valuable; may, indeed, exert a transforming influence over those who are subjected to it, giving them new aptitudes, new sensibilities, and a finer organization. Is this too much to ask? Have not twenty-five years of discussion brought us at least as far as this?

What is demanded is not the introduction of a new subject of study into an already crowded curriculum, but an organized course

of nature-study running through the whole period of school-life. The particular objects of study are not so important, but plants and minerals will naturally form in the lower schools the main part of this material. The point is, that the instruction should be continuous enough and yet fresh enough to catch and hold the mind in its varying stages of development from youth to manhood. Good collegiate must be grounded upon good preparatory work. Accepting "Reviewer's" test—that also of Johnson and Arnold—of teaching that which is "interesting to the mass of men," does it bear out his inferences? If so, let us drop this subject altogether, and not cling to the dead form of "geology as an optional study in the high schools and colleges." The ordinary college presents many disheartening sights; but I know of no one more disheartening than to see the members of a senior class who have never taken up a stone except in anger, and never thought of one except as a missile passing from hand to hand,—the *pièces justificatives* of a lecture on geology.

E. A. STRONG.
Ypsilanti, Mich., April 1.

Curves of Literary Style.

IT seems necessary to explain occasionally that in the construction of curves of literary style, concerning which two or three notes have recently appeared in *Science*, a very large number of words or sentences must be used. The method is distinctly based on a supposed constancy in the long-run. In the original article the statement is made that probably not less than one hundred thousand words or sentences would be required for the construction of a "characteristic curve." If Mr. Parker had counted only thirty sentences from "Sartor Resartus," he might have found a close agreement with the curve of the "French Revolution," or he might have found a wide divergence. In neither case would the result have had any significance. A comparison of three hundred sentences proves nothing, one way or the other.

M.
Terre Haute, Ind., April 1.

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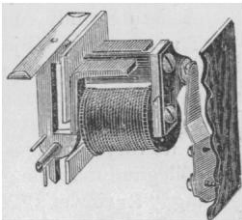
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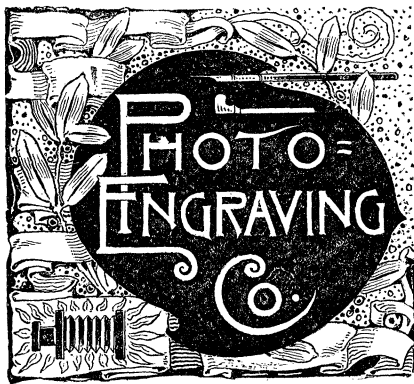
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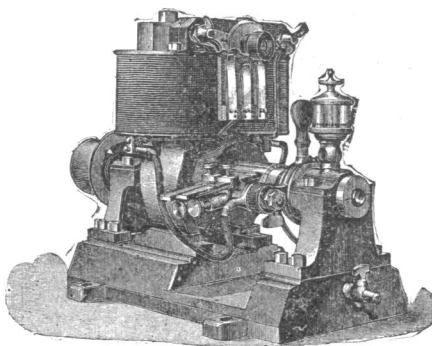
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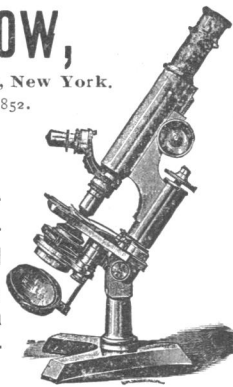
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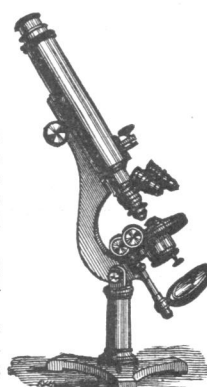
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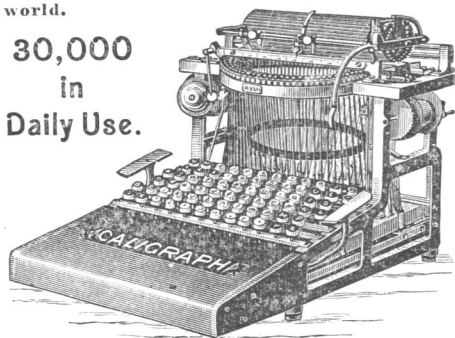
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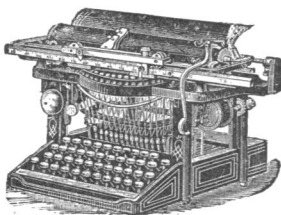
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